SELECTING FURNITURE LUMBER GRADES—See p. 11

Forest Products Journal

Vol. VI, No. 1 January, 1956

Photo by R. B. Russell, U. S. Forest Products Laboratory

New Instruments Assure Uniformly Thick and Smooth Veneer for High Quality Plywood—See Page 1

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FOREST PRODUCTS JOURNAL

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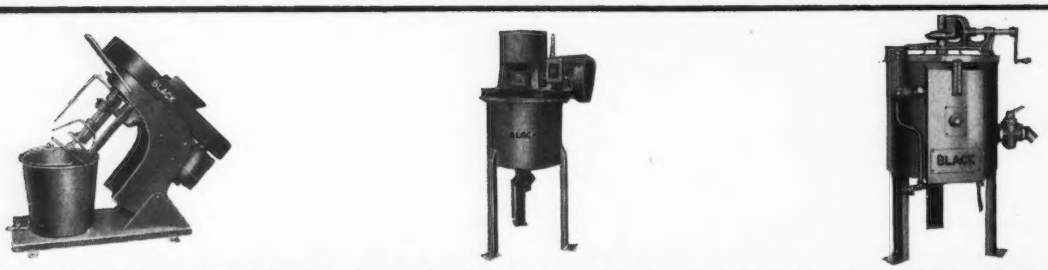

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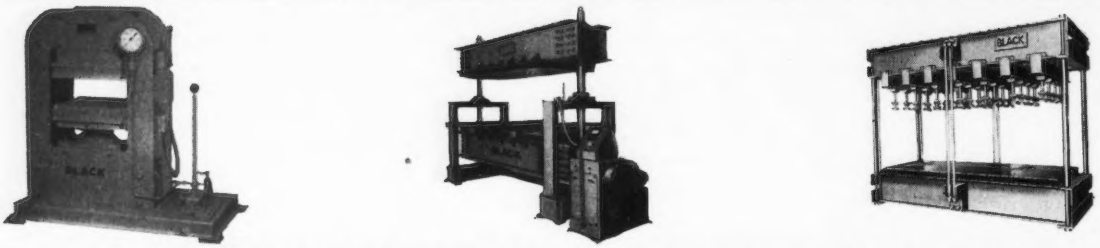
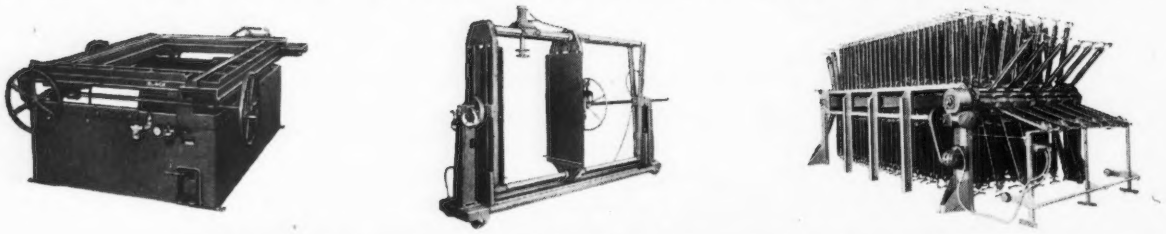


COLD PRESSES FOR MODERATE PRESSURE LAMINATING OPERATIONS



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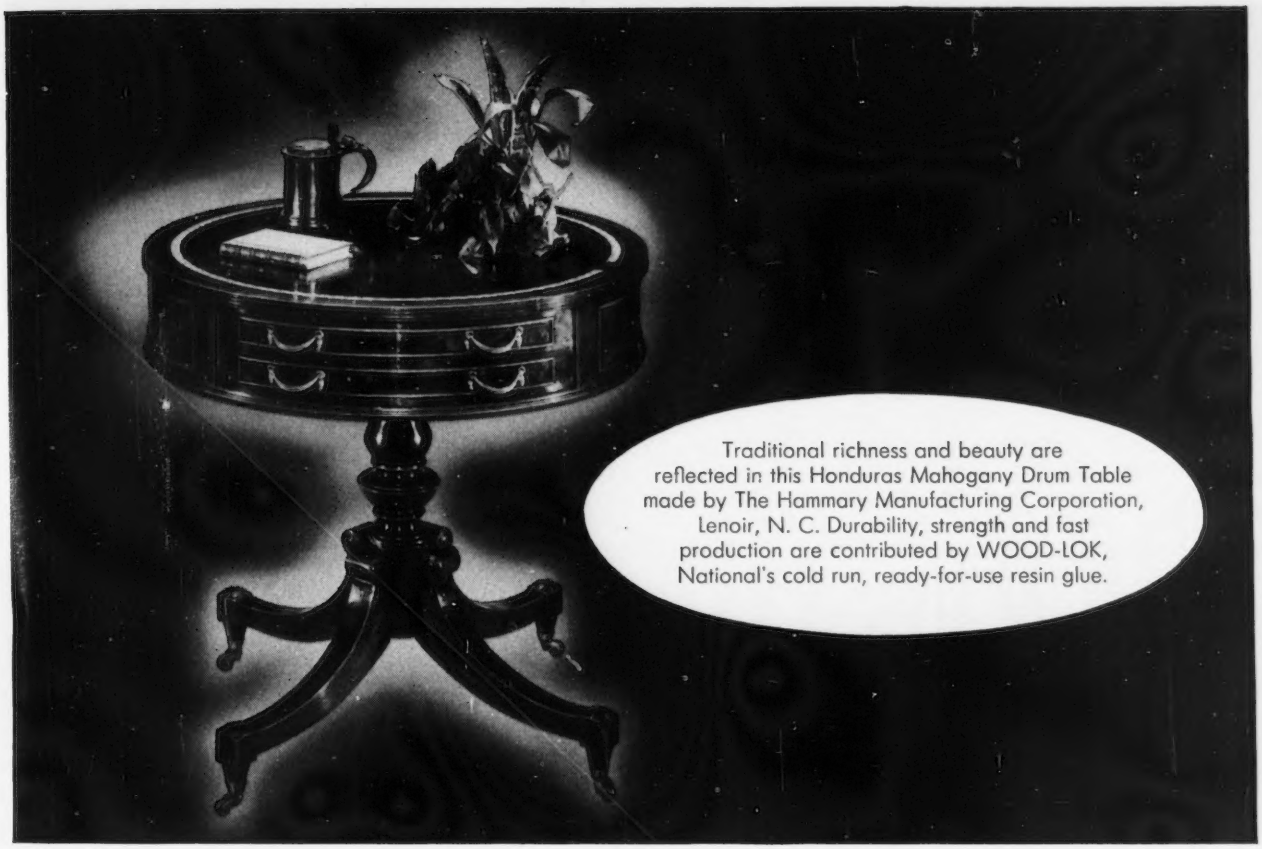

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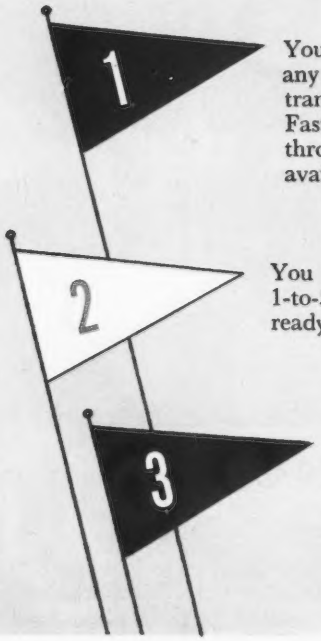

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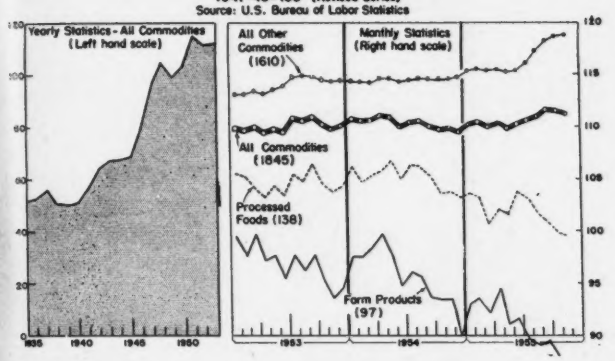
FPRS NEWS-DIGEST

Volume VI JANUARY, 1956 Number 1

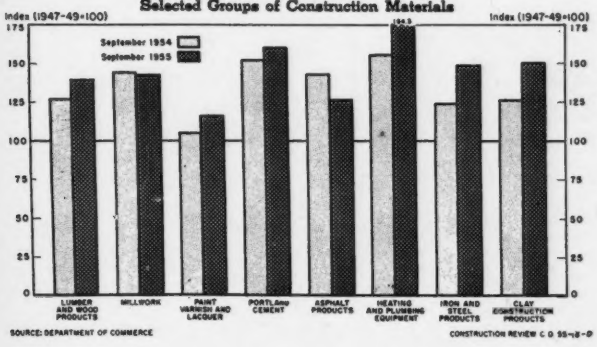
GRAPHIC TRENDS

WHOLESALE PRICE INDEXES

1947-49=100 (Revised Series)
Source: U.S. Bureau of Labor Statistics



Indexes of Materials Output
Selected Groups of Construction Materials



GROWING INTEREST in wood waste conversion to pulp chips is evident throughout U. S. and Canada. Recent Canadian conference (see page 7-A) reported immediate demand for information on barking, chipping, and utilization; U. S. Forest Products Lab article in Timber Producers Bulletin (August 1955) discussed marked interest in this utilization opportunity and gave cost estimates; American Pulpwood Assoc., 220 East 42 St., New York 17, N. Y., regularly issues Equipment Handbook Releases on debarking, chip handling, and other utilization factors.

BUSINESS OUTLOOK

KEYS TO EXPANSION of lumber industry are increased automation and greater use of sawmill residues, says J. B. Grantham, managing director of Oregon Forest Products Lab. Automatic dogging, riderless carriages, remote setworks for resaws, would increase productivity. Oregon lab is treating sawdust to overcome temporary nitrogen deficiency, improve its characteristics as soil conditioner.

GROWING NUMBER of kiln drying clubs are making valuable contributions to wood-using industries. New associations in Arkansas, Ohio Valley, Upper Michigan, and Florida-Georgia-Alabama formed in recent months have objectives of promoting efficient drying practices, increasing profits, decreasing waste, and fuller utilization of wood resources.

ACCELERATING TREND TO RESEARCH, according to Timber Engineering Co., is evidenced by their 65 per cent increase in number of private sponsored research projects during first 10 months of '55, compared with same period in '54, and 105 per cent increase over '53.

GUIDE TO EVALUATING establishment of new wood composition board plants was recently completed by Pacific Power & Light Co., Portland 4, Ore. Copies of 56-page report, "Wood Composition Boards", are available on request. The report discusses characteristics and uses of various types of synthetic boards, raw materials, manufacturing processes, plant capacities, capital investment, costs, and market potentials.

FPRS 10th National Meeting Committee Announced

R. H. BESCHER
Program

F. H. KAUFERT
Committees

G. M. HILL
Finance & Budget

W. R. SMITH
Arrangements

MRS. W. R. SMITH
Ladies Program

M. A. TARAS
Housing

J. B. VEACH, SR.
Hospitality

B. M. WITHEROW
Field Trips

A. S. TODD, JR.
Rooms & Supplies

J. B. VEACH, JR.
Registration

A. C. BAREFOOT
Registration

H. J. LOUGHEAD
Publicity

R. C. BUCHHOLZ
Publicity

W. J. DAMTOFT
Publicity

J. B. HAYWARD
Paul Bunyan Hour

R. C. GARRISON
Paul Bunyan Hour

R. G. LENOX
Paul Bunyan Hour

J. S. BETHEL
Table-top Exhibits

H. A. LOCKEMER
Table-top Exhibits

R. E. PALMER
Table-top Exhibits

W. L. IRWIN
Entertainment

R. A. WOOD
Entertainment

E. S. JOHNSON
Door Prizes

R. M. CARTER
Door Prizes

ASHEVILLE, N. C., JAN. 1956.—This city, selected both for its vast natural beauty as a vacation mecca and its proximity to the principal southeast wood industries—furniture, lumber, pulp and paper—will be the scene June 4–7 of the 10th National Meeting of the 3,000-member Forest Products Research Society.

E. S. HARRAR
General Chairman

The meeting, expected to attract upwards of 500 FPRS members and guests, is under the direction of General Chairman E. S. Harrar, Graduate School of Forestry, Duke University, Durham N.C., and Technical Program Chairman Ralph H. Bescher, Dist. Mgr., Wood Preserving Division, Koppers Co., Inc., Pittsburgh, Pa. Both are members of the FPRS National Executive Board.

Although a number of informal conferences to develop this meeting have been held over the past two years, the first official meeting of the steering committee was held last July at the Drexel Furniture Co., Drexel, N.C. This was followed by a meeting Dec. 5 in Asheville, when the full steering committee was announced.

The 1956 National Meeting will include the traditional technical sessions, meetings of 13 subject matter committees, the industry-sponsored Paul Bunyan Hour, a ladies' program, and in addition will boast a large table-top exhibit designed to provide a service to companies and organizations represented in FPRS.

Working closely with the steering committee will be FPRS Vice-President F. H. Kaufert, University of Minnesota, coordinator of subject matter committees. Committee chairmen are: Walton R. Smith, Southeastern Forest Experiment Station, Asheville, Arrangements Chairman; G. M. Hill, Drexel Furniture Co., Drexel, N.C., Finance & Budget Chairman; H. J. Loughead, Consultant, Asheville, Publicity Chairman; J. S. Bethel, N. C. State College, Table-top Exhibits Chairman; J. B. Hayward, Perkins Glue Co., High Point, N.C., Paul Bunyan Hour Chairman.

Committee personnel are: C. M. Carey, Jr., Drexel Furniture Co., Morganton, N. C., finance; R. C. Buchholz, Draper Corp., Biltmore, N. C., and W. J. Damtoft, Champion Paper & Fibre Co., Canton, N. C., publicity; John Colucci, Jr., Southern Box & Lumber Co., Wilmington, N. C., R. C. Garrison, Garrison Machine Co., States-

ville, N. C., and R. G. Lenox, Williams Furniture Corp., Sumter, S. C., Paul Bunyan Hour; H. A. Lockemer, Williams–Brownell, Inc., Asheville, R. E. Palmer, Henry County Plywood Corp., Ridgeway, Va., and P. F. DeSaix, Carborundum Co., High Point, N. C., table-top exhibits.

Asheville arrangements will be handled by: A. S. Todd, Jr., Southeastern Forest Exp. Sta., meeting rooms, signs, and supplies; B. M. Witherow, Southeastern Forest Exp. Sta., transportation and field trips; M. A. Taras, Southeastern Forest Exp. Sta., housing; J. B. Veach, Jr., Bemis Hardwood Lumber Co., Robbinsville, N. C., and A. C. Barefoot, N. C. State College, registration and tickets; W. L. Irwin, Poinsett Lumber Mfg. Co., Pickens, S. C., and R. A. Wood, Gordon Lumber Co., Asheville, entertainment and meals; J. B. Veach, Sr., Bemis Hardwood Lumber Co., hospitality; R. M. Carter and E. S. Johnson, N. C. State College, door prizes; and Mrs. Walton R. Smith, ladies program.

Regional Nominating Committees Appointed

Nominating Committees for the South–Central and Southeast Regions have been announced by FPRS President Moss B. Christian, after consultation with Section and National Officers. The committees will select candidates to serve three-year terms on the Executive Board. The positions are now held by W. Jeter Eason, Nickey Bros., Memphis, and E. S. Harrar, Duke University, Durham, N. C., whose terms expire at the 10th National Meeting June 4–7 in Asheville, N. C.

South-Central Region Nominating Committee is James Love, Texas; Mark Lehrbas, La.; Daniel Copp, Tenn.; Kenneth Chesley, Ark.; and James Haskins, Miss., Chairman.

Southeast Region Nominating Committee is G. M. Kaufman, Fla.; J. A. Vaughan, Ga.; Wilbur DeVall, Ala.: G. M. Hill, N. C.; and Walton Smith, N. C., Chairman.

Northeast Section Announces Spring Meeting Program

New officers will be elected at the Northeast Section annual meeting to be held April 19–20 in Springfield, Mass. The tentative program on the theme, "Synthetic Wood Products," has been announced by Don K. Saunders, Section Vice-Chairman and Program Chairman.

Topics to be discussed at technical sessions will include epoxy resins, densified table legs, gluing, flush doors, paper and fabric backed veneer, compreg, and design and engineering aspects of plywood. Idea exchange sessions will cover merchandising and marketing, research, primary manufacture, and education and employment. A panel discussion will cover machining, fabricating, testing, and manufacture of particle boards.

T. S. Veazey, Jr. Elected Inland Empire Section Chairman

T. S. VEAZEY, JR.

Tony S. Veazey, Jr., was elected chairman of the FPRS Inland Empire Section at the annual meeting held at Spokane, Wash., January 12–13. He succeeds Cameron Warren. Other officers named were: Dr. George Marra, vice-chairman; Irvin Wentworth, secretary-treasurer; J. H. Leuthold and John Syme, trustees.

During the technical program, Dr. George Marra, Washington State College, described a new process for high-speed production of glue-laminated 2x4's from low-grade 1-inch boards without the use of high-frequency gluing machines. Douglas Hunt, Western Pine Assoc., discussed up-grading lumber by machine-plugging knots and knot holes with patches selected to match grain and texture. The work being done nationally to revise insurance ratings on timber trusses was outlined by Elon Ellis, Timber Structures, Inc. Ellis stressed that although a building is non-combustible, it is not necessarily a good fire risk, as charred timber trusses have maintained their strength under fire conditions which caused steel structures to collapse.

The meeting concluded with a trip through the new flakeboard plant of Pack River Lumber Co. near Sandpoint, Idaho, following a description of the plant by D. L. Haynes.

28 New Student Members Enrolled in Society

FPRS recently welcomed 28 new student members—15 from Laval University, Quebec, and 13 from Oklahoma A & M College, Stillwater. The Canadian students were enrolled through the efforts of Dr. Joseph Risi, head of the Laval Dept. of Forestry. Al Pakula, assistant professor at the Oklahoma school, introduced his students to the Society.

The new student members from Laval are: L. Anctil, J. Boivin, A. Dube, R. Dumont, P. Fortin, J. Gosselin, R. Langlois, P. Lecerf, M. Lortie, C. Mercier, M. Pinard, M. Poulin, T. Sicard, M. Sirois, and P. Vezina.

The students from Oklahoma A & M are: S. DeLozier, J. Young, D. English, R. Ellis, H. Cheatham, V. Hooker, J. Clikenbeard, J. Adams, J. Helm, D. Turman, J. Florer, O. Grossarth, and J. Gregg.

Michigan and Yale Plan 1956 Wood Award Entries

Two schools, University of Michigan and Yale University, have indicated that they have graduate students planning to enter the 1956 Wood and Wood Products Award competition. Other graduate students are reminded that deadlines are April 15 for the submission of tentative titles and May 1 for complete papers. Entries should be submitted to the Executive Secretary, Box 2010, University Station, Madison 5, Wis.

Dr. Alexis J. Panshin, chairman of the Industry–Education Committee, has announced that papers based on research conducted during the 1954–55 school year are eligible, regardless of whether the research was completed prior to May, 1955. Graduate students in attendance for at least one quarter or semester during the 1955–56 school year may submit papers based on research completed after May 1, 1955. Papers previously submitted in Wood and Wood Products Award competition are not eligible for the 1956 contest.

The 1956 awards are open to students working for Master's or Doctors' degrees. The first place winner will receive $350 and second place, $150, with the awards being presented at the FPRS 10th National Meeting at Asheville, N. C.

INDUSTRY NEWS

Waste Conversion to Chips Increases in Canada

Progress in the conversion of sawmill waste to pulp chips was indicated in a report given at the fifth annual meeting of the Research Co-ordinating Committee on Utilization of Sawmill Waste for Pulp, held at the Forest Products Laboratories of Canada,

Col. J. H. Jenkins, top left, greets J. Burchill, Geo. Burchill & Sons Ltd., at meeting of research co-ordinating committee in Ottawa. Center is G. E. Bell, committee secretary. Lower photo shows part of committee at meeting.

Ottawa. In 1955, about 850,000 cords of slabs and edgings were chipped in British Columbia, while 100,000 cords were chipped in Eastern Canada.

The committee generally agreed that several factors are still restricting the expansion of this method of utilization in Eastern Canada. Among these is the need for additional information on the economics of barking, chip production, and utilization. Another limiting factor was believed to be the lack of sufficient information on the part of many operators. It was noted by the committee, however, that manufacturers are attempting to produce low-cost barkers suitable for use at smaller sawmills.

Col. J. H. Jenkins presided at the meeting of the committee. The group's main functions are collection, preparation, and dissemination of information on development of barkers and methods for handling and transporting sawmill wastes.

Hardwood Association Organized in Northwest

The Northwest Hardwood Association, comprising Washington, Oregon, and British Columbia, held an organizational meeting recently in Seattle. Among its objectives are conservation and utilization of Pacific Coast hardwoods, establishment of log and lumber grading rules, and extension and stabilization of markets. Association offices have been established at 3253 Commodore Way, Seattle, with Harry O. Mitchell, named secretary-manager.

SHORT COURSES

Forest Products Lab Plans 80th Kiln-Drying Course

New methods that speed drying and curtail degrade will be highlighted at the 80th Kiln–Drying Demonstration to be conducted April 16–27 at the U. S. Forest Products Lab., Madison, Wis.

Subjects to be covered include the basic principles of air and kiln drying; types of kilns; kiln equipment, operation, and tuneup; and moisture control during storage and production. Participants will dry charges in kilns under the supervision of Laboratory specialists and may discuss their individual seasoning problems with members of the Laboratory staff.

The $200 fee for the demonstration includes materials and publications furnished enrollees for use as texts. Further information may be obtained by writing U. S. Forest Products Lab., Madison.

TECO Schedules Gluing Short Course March 5–9

Typical gluing problems encountered in furniture production, laminated timbers, and other wood products, will be covered at the 25th Teco short course in wood adhesives and gluing, to be held March 5–9 at the laboratory of Timber Engineering Co., 1319–18th St. N. W., Washington 6, D. C.

The five-day course will consist of lectures, demonstrations, and enrollee participation, with emphasis on practical applications. Subjects will include fundamentals, types of glues, gluing and testing methods, and quality control.

Penn State Offering Lumber Grading Course

A short course in hardwood lumber grading is being offered by Pennsylvania State University School of Forestry March 12 to 16. The course will cover grading and inspection of native hardwoods.

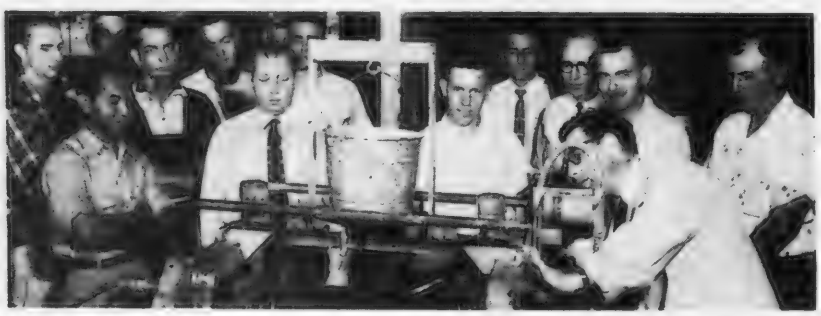
Additional information may be obtained from Orvel A. Schmidt, School of Forestry, Pennsylvania State University, University Park, Pa.

Statistics Short Course Scheduled at N. C. State

A short course in statistics will be given at North Carolina State College, Raleigh, February 12–18. Designed to acquaint research workers with modern statistical techniques, the course will cover elementary statistical analysis, regression analysis, and experimental design. Guest lecturers will inclue W. G. Cochran, Johns Hopkins University; S. L. Crump, University of Rochester; and J. S. Hunter, American Cyanamid Co.

Further information may be obtained from Institute of Statistics, North Carolina State College, Box 5457, Raleigh, N. C. Fee for the course is $100.

More than 200 years' experience in wood seasoning are represented by these veterans of the U. S. Forest Products Laboratory who will conduct kiln-drying demonstration at Madison, Wis. in April. They are, left to right: K. E. Kimball, L. V. Teesdale, J. S. Mathewson, R. C. Rietz, R. C. Baltes, E. F. Rasmussen, J. M. McMillen, J. A. Jenson, and E. C. Peck.



Practical application of gluing techniques will be emphasized at 25th Teco short course in wood adhesives, to be held March 5–9 at Timber Engineering Co. lab. Above photo shows Teco technologist T. J. Ginn discussing details of glue spreader during previous course.

NAMES IN THE NEWS

Ray C. Reinhartsen Named General Sales Manager

R. C. REINHARTSEN

Ray C. Reinhartsen, formerly vice-president and general manager of Onsrud Machine Works, Inc., has been named general sales manager of Ekstrom, Carlson & Co., Rockford, Ill. Reinhartsen has an extensive background in all phases of machinery and sales.

Fred J. Heid, associated with the machinery firm for the past eight years as general sales manager, has been appointed an exclusive representative for the firm's aircraft machinery division. He will serve accounts in that industry in the eastern U. S.

C. J. Williams Dies

Charles J. Williams, Chairman of the Board of Moore Dry Kiln Co., died January 2 at Jacksonville, Fla. Mr. Williams joined the Society as a charter member in 1947.

FPRS NEWS–DIGEST
Continued on page 25–A

You're Welcome
TO READ OUR MAIL

MOHAWK VALLEY KILN DRYING CO.
NELLISTON, N. Y.

MOHAWK VALLEY LUMBER CO.
FORT PLAIN 4-5511

Standard Dry Kiln Co
P. O. Box 5708
Indianapolis, Ind.

Dear Sirs:

Thank you for the information in your recent letter. It has been very helpful, as all your suggestions have been. May I take this opportunity to say that we are more than pleased with the operation of our two Standard kilns over the past two years. We are drying a great deal of thick Maple, green from the saw, with considerable success.

Very truly yours,

Carl H. Esdorn, Owner

● This is a photograph of the STANDARD Dry Kiln installation referred to by Mr. Esdorn. The two kilns are of the end piling, double-track type. They are 24 feet wide by 42 feet long, and have a control room and a boiler at the back end. Heated with an automatic oil-fired boiler, the kilns are used for the commercial drying of all kinds of wood grown in the Appalachian region.

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Insurance for the Future

ONE OF THE MAIN PURPOSES of FPRS is to encourage our industry to employ more technically trained men and women. In this fast-moving industrial era of highly vocationally skilled workmen and increasing specialization in technical colleges, no company without a well-balanced management and production team can long endure against the onslaughts of their better-staffed and organized competition. I do not intend to belabor the point of increasing competition. Nor are my thoughts directed so much to our larger companies who are already using tried and tested principles of technical manpower recruitment, but rather to the small companies which make up well over 90% of our industry.

M. B. Christian

You are no doubt familiar with how other large industries are tackling this problem of technical manpower . . . . the corps of employment specialists they send each year to our universities to interview the "cream" of our graduating talent . . . . their "summer opportunities" and subsequent "on-the-job training programs".

Are there not ways in which smaller companies in the wood industry can do a similar recruitment job in our wood technology schools and lend our students assistance and encouragement for the future?

I believe our Society holds a partial answer to this problem. FPRS' National Employment Committee, under the direction of Dr. Newell Norton, Penn State University, has been quietly working behind the scenes during the past year developing a long-range program. One step in this program which they emphasize is summer months "on-the-job" training—inviting promising young men into your plants during their vacation periods. Norton's committee is at work now on plans for this summer and invites your cooperation. Here's how the plan will work:

First, the committee of eight geographically distributed university and industrial men are contacting local wood industries to crystallize their needs for a limited number of students this summer. Then these lists of interested firms will be sent to universities within specific geographic areas in order to give them first opportunity at filling local jobs, and subsequently sent throughout the United States. Each school will have a designated faculty representative who will bring available temporary job openings to the attention of his student body. Finally, the initiative for contacting the interested companies will be left to the individual students who will be expected to "sell" themselves and their services to prospective employers.

If you agree with me that the future success of our industry is based on the friendship and help we offer our youth of today, won't you participate in this program by offering a potential future employee a summer time opportunity in your plant? Remember, the young man to whom you give a chance this year may well turn out to be the difference between profit or loss, success or failure, in your company five years from today.

If you are interested in participating, contact Chairman Newell Norton, School of Forestry, Penn State University, University Park, Pennsylvania, at your earliest opportunity.

MOSS B. CHRISTIAN, *President*

FPRS Welcomes Boise Payette Lumber Co. As Supporting Member

Boise Payette Lumber Co., Boise, Idaho, has become a FPRS Company Supporting Member, joining the growing list of firms helping the Society to promote the scientific progress of the forest products industry.

JOHN L. ARAM

The firm is headed by John L. Aram, President, a graduate of U. of Idaho Business School. He was associated with Potlatch Forests, Inc., before joining Boise Payette in 1949 as a consultant on forestry and sawmilling. Mr. Aram was promoted to Manager of Manufacturing in 1949, Executive Vice-President in 1953, and President in May 1955.

Steele Barnett, Product Development Manager, is the company's designated representative to FPRS. Since his firm joined the Society, Mr. Barnett wrote: "Research is undoubtedly the keystone to the lumber industry's future. The interchange of research information through the Society certainly warrants the support of every company looking to the future."

Largest of Boise Payette's three sawmills is this one at Emmett, Idaho.

FPRS' new supporting member is located in South Central Idaho and is made up of three sawmills in Idaho; 88 retail yards in Idaho, Utah, and Wyoming; and a large wholesale distributing firm serving the Intermountain area.

Boise Payette joins the list below of more than 100 Company Supporting Members.

Meet FPRS 100 Company Supporting Members

ALABAMA
W. T. Smith Lumber Co., Chapman

ARKANSAS
The Crossett Co., Crossett
Dierks Forests, Inc., Mountain Pine
Southern Lumber Co., Warren

CALIFORNIA
California Redwood Association, San Francisco
L. J. Carr & Co., Sacramento
Crane Mills, Corning
Ivory Pine Co., Dinuba
National Wood Treating Corp., Oroville
Philadelphia Quartz Co. of California, Berkeley
Scott Lumber Co., Inc., Burney
Tarter, Webster & Johnson, Stockton
Winton Lumber Co., Martell
E. K. Wood Lumber Co., San Francisco

GEORGIA
Southern Wood Preserving Co., Atlanta

IDAHO
Boise Payette Lumber Co., Boise

ILLINOIS
The Dean Company, Chicago
General Electric, Illinois Cabinet Plant, Rockford
Greenlee Tool Co., Rockford
Edward Hines Lumber Co., Chicago
Illinois Interior Finish Co., Chicago
Johnson & Carlson, Chicago
Masonite Corp., Chicago
Mattison Machine Works, Rockford
Sherwin-Williams Co., Chicago
Steger Furniture Mfg. Co., Steger

INDIANA
The Dunbar Furniture Mfg. Co., Berne
National Homes Corp., Lafayette
The Wood-Worker & Veneers and Plywood, Indianapolis

IOWA
Curtis Co. Inc., Clinton

MARYLAND
J. I. Wells, Salisbury

MASSACHUSETTS
Draper Corp., Hopedale
Heywood-Wakefield Co., Gardner
A. G. Spalding & Bros., Inc., Chicopee

MICHIGAN
Baker Furniture, Inc., Grand Rapids
The Dow Chemical Co., Midland
Everett Piano Co., South Haven

MINNESOTA
Mereen-Johnson Machine Co., Minneapolis
Rilco Laminated Products, Inc., St. Paul
Wabash Screen Door Co., Minneapolis

MISSOURI
Monsanto Chemical Co., St. Louis

MONTANA
Intermountain Lumber Co., Missoula

NEVADA
Vaughn Millwork Co., Reno

NEW YORK
American Defibrator, Inc., New York
Behr-Manning Corp., Troy, N. Y.
Borden Co., New York
Peter Cooper Corps., Gowanda
Georgia Pacific Plywood Co., New York
Oval Wood Dish Corp., Tupper Lake
Reichhold Chemicals, Inc., White Plains
The Upson Co., Lockport
U. S. Industries, Inc., New York
United States Plywood Corp., New York

NORTH CAROLINA
Deluxe Saw & Tool Company, High Point

OHIO
The Baldwin Piano Co., Cincinnati
Coe Manufacturing Company, Painesville
The Kirk & Blum Mfg. Co., Cincinnati
Moraine Box Company, Dayton

OREGON
Cascades Plywood Corporation, Portland
Forest Fiber Products Co., Forest Grove
Mater Engineering, Corvallis
J. Neils Lumber Co., Portland
Oregon Lumber Co., Baker
West Coast Lumberman's Assn., Portland

PENNSYLVANIA
Blaw-Knox Company, Pittsburgh
Firth Sterling Corp., Pittsburgh
Koppers Company, Inc., Pittsburgh
Perkins Glue Co., Lansdale
United States Steel Homes, Inc., Harrisburg
Wood Metals Industries, Inc., Kreamer, Snyder County

SOUTH CAROLINA
Lightsey Brothers, Miley

TENNESSEE
E. L. Bruce Co., Memphis
Chapman Chemical Company, Memphis
Memphis Hardwood Flooring Co., Memphis
Nickey Bros., Inc., Memphis

TEXAS
Wm. Cameron & Co., Inc., Waco
Kirby Lumber Corporation, Houston
Wynnewood Products Co., Jacksonville

VERMONT
Beecher Falls Mfg. Corp., Beecher Falls
Fyles & Rice Co., Inc., Bethel

WASHINGTON
American Marietta Co., Seattle
Biles Coleman Lumber Co., Omak
Cascade Lumber Co., Yakima
Columbia Plywood Co., Inc., Seattle
Deer Park Pine Industry, Inc., Deer Park
Diamond Match Co., Spokane
Douglas Fir Plywood Association, Tacoma
The Long-Bell Lumber Co., Longview
Simpson Logging Co., Shelton
Sumner Iron Works, Everett
Weyerhaeuser Timber Co., Tacoma

WISCONSIN
Harnischfeger Corp., Port Washington
Marathon Corp., Rothschild
Mosinee Paper Mills Co., Mosinee
D. J. Murray Mfg. Co., Wausau
Paine Lumber Co., Oshkosh

ALASKA
Ketchikan Spruce Mills, Ketchikan

CANADA
British Columbia Lbr. Mfrs. Assn., Vancouver B. C.
Canadian Forest Products Limited, New Westminster, B. C.
Dominion Electrohome Industries, Ltd. Kitchener, Ont.
The Knight Mfg. & Lbr. Co. Ltd., Meaford Ontario
MacMillan & Bloedel Limited, Nanaimo B. C.
A. S. Nicholson & Son, Ltd., Burlington, Ont

Instruments for Alining the Knife and Nosebar on the Veneer Lathe and Slicer[1]

H. O. FLEISCHER

Wood Technologist, Forest Products Laboratory,[2] Forest Service, U. S. Department of Agriculture

Veneer must be uniformly thick and smooth to assure high quality plywood. To obtain uniform thickness and smoothness, the knife and nosebar on the veneer lathe or slicer must be properly positioned. This article describes instruments developed to accurately measure knife angle and the alinement between the knife-edge and nosebar-edge.

THE MOST DIFFICULT TASK involved in cutting veneer on the lathe or slicer is the relative positioning and alinement of the knife and the nosebar. The task involved is somewhat similar on the two types of machines, and may be illustrated by reference to Figure 1. This figure shows the relative positions of the knife and the nosebar on the carriage of the veneer lathe. The angle at which the knife stands and the relative position of the nosebar with respect to that of the knife edge are the most critical factors.

The knife angle is the angle formed between a horizontal plane passing through the knife edge and a plane passing over the ground face of the knife. The horizontal opening of the nosebar is the horizontal distance between the knife edge and a vertical plane passing through the edge of the nosebar. The vertical opening of the nosebar is the vertical distance between the knife edge and a horizontal plane passing through the lower edge of the nosebar.

On lathes it is not uncommon to have knives and nosebars up to 10 feet or more in length. On veneer slicers, the length may be as much as 17 feet. It is important that the positioning and alinement of the knife and the nosebar be identical along the entire length. Many of the difficulties encountered in cutting veneer, either on the lathe or on the slicer, develop because of a misalinement of the knife and nosebar along a relatively short fraction of their length.

[1] Presented at a meeting of Northeast Section, FPRS, April 28-29, 1955, in Glens Falls, N. Y.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin

The Author: Dr. Herbert O. Fleischer is in charge of research in veneer and plywood at the Forest Products Laboratory and is Chairman of the FPRS Veneer and Plywood Committee. He holds B.S.F. and M.F. degrees from the U. of Michigan, Ph.D. from Yale U.

Knife Angle

For satisfactory cutting, the knife angle, or "pitch", may be approximately 90°, or it may vary as much as 2° to 3° in either direction from the 90° position, depending primarily on the species and the thickness of veneer being cut. On the lathe, the angle may also vary depending upon the diameter of the bolt being cut. The knife angle is important because it determines the width of the wood bearing on the ground surface of the knife immediately beneath the knife edge. This in turn affects the degree of stress acting on the knife edge during cutting. If this stress becomes too great, it tends to deflect the knife edge away from the bolt and the veneer will not be uniform in thickness. Vice versa, if it becomes too small, it may allow the knife edge to vibrate, and corrugated veneer will be produced.

Considerable information is available on the knife angles that are used to cut veneers of different species and thicknesses.[3] For veneer of many species, 1/8 inch thick, the best knife angle appears to lie between 89°, 30' and 90°. For thicker veneer the angle may be somewhat smaller; for thinner veneer, on the other hand, the optimum angle becomes progressively greater, and may be as great as 92° or more for veneer 1/100 inch thick. These settings will hold only when the knife is ground to a bevel of 20 to 21° and its edge is horizontally in line with the center of rotation of the spindles.

[3] Fleischer, H. O. 1949. Experiments in rotary veneer cutting. Proc. For. Prod. Res. Soc. III: 137-155.

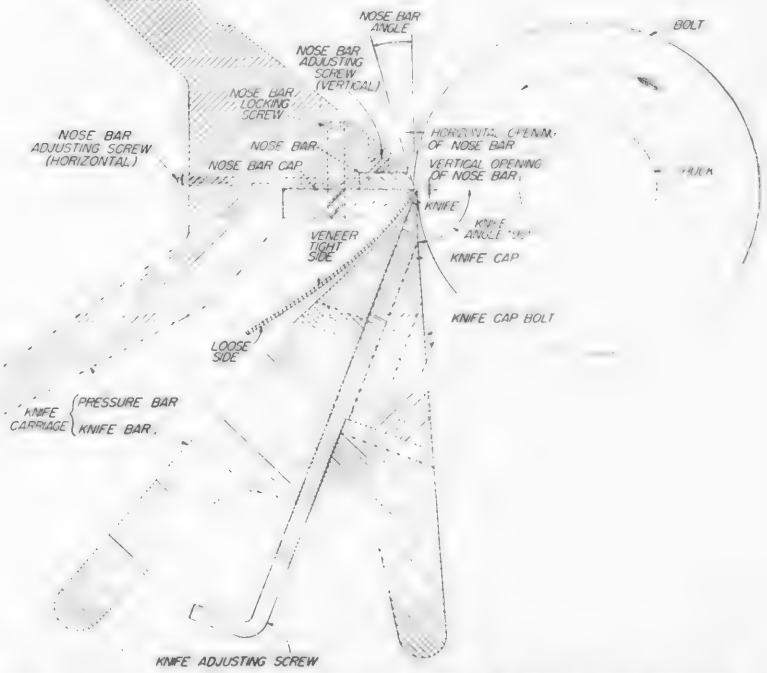

Fig. 1.—Cross section of carriage on veneer lathe, with bolt in cutting position.

Fig. 2.—Use of machinist's level for adjusting knife angle to 90°.

The angle of the knife is adjusted by turning certain screws that control the carriage supports. This causes the entire carriage to tilt or rotate about the knife edge. On some lathes it is possible to set these screws in such a way that the knife angle will change automatically as the carriage moves in or out. When properly set, the knife angle will decrease gradually as the diameter of the bolt being cut decreases. In cutting hardwood logs of average size, a drop in the angle of ¼ to ½ degree will be adequate to keep a constant bearing on the ground face of the knife.

For most purposes it is best to set the knife edge horizontally in line with the spindle centers on the lathe. When the spindle bearings become worn, the spindles have a tendency to rise during cutting because of the upward thrust of the knife as it cuts into the wood. Under these conditions it is sometimes considered advisable to set the knife edge from 1/16 to ⅛ inch higher than the spindle centers, or a distance equal to that which the spindles will rise during cutting. This is a variable factor and hard to gage exactly. Hence this adjustment may not be entirely satisfactory. Raising the knife has an effect similar to that of lowering the knife angle. The angle may therefore have to be increased when the knife edge is raised. On the other hand, if the knife edge is not raised to compensate for wear in the spindle bearings, the knife angle may have to be decreased somewhat for best results.

Similar information has not been published regarding the comparable setting on the veneer slicer. It appears that the knife angle setting, although critical, is not greatly affected by species or thickness of veneer being cut. Knife angles of less than 90° are not practical on the slicer because the heel of the knife would rub on the surface of the flitch. A setting of about 90° 15' (that is, with the ground face of the knife inclined slightly toward the flitch) appears to be widely used for slicing a large variety of veneers. Although this setting apparently need not be varied greatly as the material being cut changes, it is nevertheless critical and must be properly made to produce sliced veneer of uniform thickness.

A small machinist's level is sometimes used in setting a 90° angle of the knife on the lathe or slicer. The process is illustrated in Figure 2. On the lathe many operators will make an initial setting at 90°, and will make subsequent adjustments without instruments as the need for such adjustment becomes apparent during the cutting of the veneer.

Alinement of Nosebar with Knife Edge

The alinement of the edge of the nosebar with the edge of the knife should be as nearly perfect as possible. Irregularities in the horizontal opening may result in the production of thicker or thinner veneer at the point of irregularity than elsewhere, and this in turn may result in the development of high spots on the bolt or the flitch that is being cut. The irregularities in the surface of the wood become increasingly bad until the cutting must stop.

The proper alinement of the knife and nosebar becomes more difficult as the length of the machine increases. The adjustment is much more critical on the veneer slicer than on the lathe, since any slight irregularities that may occur seem to be aggravated by the intermittent cutting action on the slicer. Veneer cutters who have learned their trade on the lathe may therefore find it difficult to aline the knife and nosebar on a veneer slicer, whereas it is said that experienced slicer operators usually have no difficulty in this respect when working on the lathe.

Customarily, the nosebar is alined to the edge of the knife by feel. The knife is first clamped to the carriage. Next, the nosebar is placed in position, with its lower edge slightly above the edge of the knife. It is then moved ahead until its edge is vertically above the knife edge. At this point the tedious job of horizontally alining the nosebar edge to the knife edge begins. The operator usually depends entirely on the sensitivity of his thumb to tell

Fig. 3.—Checking the alinement between knife-edge and nosebar-edge by feel.

when the two edges are in alinement, as illustrated in Figure 3. He works from one end of the machine to the other, springing the nosebar in or out as required. In order to get a perfect alinement it is best to begin at one end of the knife and to work progressively toward the other end without interruption. It is difficult to go back to some local irregularity and make an adjustment, for in so doing, a misalinement may be created at each side of the adjusted point. In making this alinement, more than in any other adjustment on the lathe or the slicer, the skill and experience of the operator are important.

Once the proper alinement has been attained, the entire pressure bar casting can be moved horizontally to provide the proper horizontal opening between the knife edge and the nosebar, depending upon the thickness and type of wood being cut. If the logs or flitches being cut have been heated to a high temperature, the thermal expansion of the metal parts that occurs as the cutting progresses may cause outward and downward bowing of the pressure bar and upward bowing of the knife. The resulting misalinement is usually a gradual one. It has been observed that the vertical opening between knife edge and nosebar edge may decrease as much as 0.010 to 0.020 inch at midlength on an 8-foot machine. A readjustment can be made by means of heavy screws in the A-frame tension rods that are often used on a long pressure bar. Figure 4 shows such an adjustment being made on the veneer slicer.

Horizontal Opening

The horizontal opening between the knife and the nosebar is usually somewhat less than the thickness of the veneer being cut. Although practice among veneer cutters varies widely, the best veneer is usually cut when the opening is such that the wood is considerably compressed as it is cut. For many species, a pressure just short of that required to compress the veneer permanently seems to be best.

Fig. 4.—Adjusting tension rods to compensate for thermal expansion of knife and nosebar.

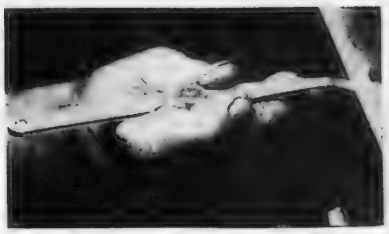

Fig. 5.—Use of a feeler-gage to measure the vertical opening between knife-edge and nosebar-edge.

In some softwood species, the development of "shelling", or ring separation, limits the pressure that may be applied. On the other hand, if the pressure applied by the nosebar is not great enough, the veneer has a tendency to develop deep checks at the point where it bends over the knife edge. Such veneer is known as "loose" or "open" veneer. The optimum setting varies widely with the species and thickness of veneer being cut, so that no general rule can be given.

A good alinement of the nosebar and knife edge is required if the horizontal opening is to be kept at its best for cutting tight and smooth veneer. Local irregularities in alinement that might cause trouble in cutting when a good nosebar pressure is applied often are hidden when a relatively low pressure is applied during cutting, For this reason, operators who do not take the time or effort to get a good alinement frequently use inadequate nosebar pressures and produce loose and rough veneer.

Vertical Opening

The vertical opening between the knife edge and nosebar seems to be the least critical of the three adjustments described. The height of the nosebar edge above the knife edge is usually such that the maximum pressure transmitted through the veneer will come to bear slightly below the edge of the knife. This places the wood in compression as it is being cut by the knife, and prevents it from developing deep checks as it bends over the knife edge. Although the optimum settings for veneer of different types and thicknesses have not been thoroughly explored, good results have been obtained on the lathe with vertical openings of 0.005 to 0.030 inch, varying in direct proportion to the thickness of the veneer being cut. On the veneer slicer, on the other hand, vertical openings of 0.030 to 0.060 inch are frequently used, and seem to give good results with veneers of a great variety of types and thickneses. Other things being equal, the higher settings are often preferred because they permit slivers to clear themselves more readily.

The methods used for measuring the vertical opening are frequently rather crude. Sometimes a 6-inch metal pocket rule about 1/32 inch thick is used as a measure by inserting it horizontally between the knife edge and the lower part of the nosebar. A check is made at several points along the length of the knife, and if the rule when supported by the lower surface of the nosebar and the edge of the knife rests approximately in the horizontal position, the setting is considered to be satisfactory.

A more accurate way of making this adjustment is by means of feeler gages of various thicknesses. In this case the nosebar is moved ahead so that its edge is approximately above the edge of the knife. Thin metal strips of known thickness, chosen to measure an opening of the exact dimension desired, are inserted between the bar and the knife. The bar is adjusted up or down until the proper dimension is obtained. This method of measurement is illustrated in Figure 5.

The effect of an improper vertical opening between knife edge and nosebar edge is generally reflected in the smoothness of the veneer produced. Horizontal adjustment of the nosebar will generally not eliminate such roughness. On the veneer slicer an improper vertical opening may also result in non-uniform thickness of each sheet of veneer, the veneer being either to thick or too thin at the end of the stroke.

Making Adjustments by Instrument

Two instruments have been developed at the Forest Products Laboratory that are helpful in setting the knife angle and the horizontal opening between the knife edge and the nosebar. These instruments make it possible for a novice to make certain adjustments on the lathe or the slicer. If records are kept of the settings that give good results with certain types of veneer, the operator will soon acquire the information necessary to enable him to cut good veneer consistently. Should he have a particularly thick-skinned thumb that will not permit him to make the extremely accurate alinement between knife edge and nosebar edge that is required on a long slicer or lathe, the horizontal-opening indicator will nevertheless enable him to get a good setup in record time.

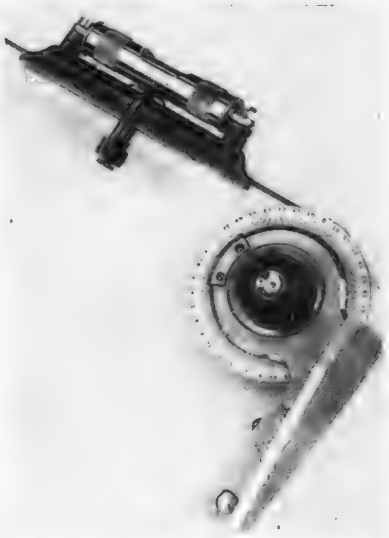

Fig. 6.—Knife-angle indicator developed by U. S. Forest Products Laboratory.

Knife-Angle Indicator

The knife-angle indicator is made by combining a machinist's protractor with an accurate leveling bubble. The resulting instrument is shown in Figure 6. The short arm of the protractor is provided with a flat plate that fits against the ground surface of the knife. The plate is roughly triangular in shape, and is broader at the top than at the bottom. Two small brass pins protrude near the top of the plate. These pins may be fitted over the edge of the knife in order that the instrument will not be tilted while in use. Care must be used to avoid damaging the knife edge.

To the longer arm of the protractor, a machinist's precision level is attached. A 4-inch level with a ground and graduated vial has been found satisfactory for this use. The two instruments required to make the knife-

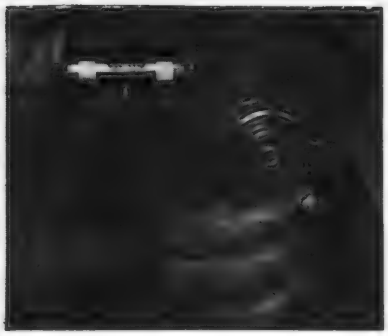

Fig. 7.—Use of the Forest Products Laboratory knife-angle indicator.

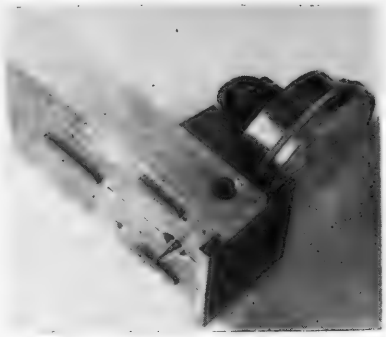

Fig. 8.—Horizontal-opening indicator developed by U. S. Forest Products Laboratory.

Fig. 9.—Use of the Forest Products Laboratory horizontal-opening indicator.

angle indicator can be purchased for less than $25.

The use of the indicator in measuring the angle at which the knife stands in the lathe or slicer is illustrated in Figure 7. By adjustment of the horizontal arm until it is level, the angle at which the knife stands may be read directly to a fraction of a degree on the vernier scale of the protractor. Conversely, if the knife is to be set to a certain angle which has been predetermined to be suitable for cutting a certain type of veneer, the angle is preset on the protractor and the instrument is clamped in this position. The instrument is then placed against the knife, and the carriage is tilted until the proper setting has been made. The instrument is also useful for determining whether the two ends of a long knife are set at an identical angle.

As indicated above, the knife-angle adjustment is an extremely important one on the lathe, for the knife angle must be changed frequently with changes in species, in thickness of veneer being cut, and for critical work even with the diameter of the bolt in the lathe. On the veneer slicer, on the other hand, readjustment is seldom made after the proper angle has once been attained. Whether this practice is correct has not been investigated.

Horizontal-Opening Indicator

An accurately calibrated dial-gage indicator, reading to 0.0001 inch, is used in the construction of the horizontal-opening indicator. The dial-gage indicator is mounted on a flat aluminum block, with its stem inserted through a hole in the block in such a way that it can be moved in or out to obtain a zero adjustment. One surface of the flat plate, which is intended for contacting the ground surface of the knife, is provided with three brass shoes that extend slightly beyond its surface. When the instrument is in use, these three shoes are placed firmly in contact with the ground surface of the knife. The dial indicator is adjusted so that it will read zero when the gage stem and the brass shoes are resting against a flat plate.

The upper end of flat plate is equipped with a smaller plate that protrudes beyond its edge at right angles to the major surface of the larger plate. The distance from the center of the dial-indicator stem to the lower surface of the smaller plate is slightly less than the thickness of the nosebar on the lathe or slicer.

Instruments Available

The knife-angle and horizontal opening indicators developed by the U. S. Forest Products Lab are being manufactured by Wisconsin Foundry & Machine Co., 623 E. Main St., Madison, Wis. (See advertisement, page 28–A).

The horizontal-opening indicator is shown in Figure 8. Figure 9 shows the instrument in use. The stem of the dial indicator projects above the knife edge until it contacts the edge of the nosebar. The dial indicator then shows, to an accuracy of 0.0001 inch, the magnitude of the horizontal opening between the knife edge and the nosebar edge.

The horizontal-opening indicator is used to advantage in alining the nosebar edge to the knife edge on the lathe or slicer. The machine operator's helper fits the instrument against the knife. The operator, working on the opposite side of the carriage, observes the reading on the dial from above and adjusts the nosebar in or out as required to get the proper setting for the thickness of veneer to be cut. The instrument is moved along the knife and readings are taken at distances approximately equal to the distances between the sets of push-pull screws that are used to adjust the nosebar. Once the operator and his helper have worked across the length of the knife, the alinement will usually be perfect from end to end.

The horizontal-opening indicator is also used to set the horizontal opening for any given thickness and type of veneer. Records should be kept of the settings that are found to be suitable for cutting veneer of different types and thickness. When a change is to be made in the type of veneer to be cut, the predetermined nosebar opening is obtained merely by taking a reading and making an adjustment at each end of the knife.

When heated bolts or flitches are cut on the lathe or slicer, particularly on a long machine, the thermal expansion that occurs in the metal parts may quickly cause a misalinement between the nosebar and the knife. After the metal parts are thoroughly heated, a reading is taken at each end and at the middle of the knife. The proper adjustment is then made, with the instrument at the middle of the knife, to bring the opening at this point equal to that at the two ends by means of the heavy A-frame tension rods attached to the pressure-bar casting.

Vertical-Opening Indication

No special instrument has as yet been designed for measuring the vertical opening between the knife and the nosebar, since this adjustment is considered less critical than the other two adjustments described above. If further investigation should show that any advantage can be gained by a refinement in this adjustment, an instrument for measuring the vertical opening could probably be made, or a second dial gage could be attached to the horizontal-opening indicator to make the vertical reading.

Conclusion

U. S. Forest Products Laboratory investigations have shown that good veneer can be cut consistently on the lathe or slicer when instruments developed to measure knife angle and horizontal opening between knife edge and nosebar are used. To a limited extent, the instruments take the human element out of veneer cutting.

An operator who has learned to use the instrument method of setting the knife and nosebar on the lathe or slicer will find his chances of cutting uniformly good veneer greatly increased.

Addendum

Since the above paper was first presented, additional information has come to the attention of the author regarding instruments that are presently in use in the industry for setting the horizontal and vertical openings on the veneer lathe and slicer.

Several slicer operators have developed and made their own instruments for measuring the horizontal opening between the knife edge and nosebar edge. In general these employ a principle similar to that described above; namely, incorporating a base plate or shoe that rests against the ground surface of the knife, and a measuring device for indicating the horizontal distance from this plane to the nosebar edge. One such instrument includes a small light that flashes when the gage stem makes contact with the nosebar edge.

At least two systems are in use for gaging the vertical opening, In one case the width of the opening is estimated from the width of a beam of light that is passed through the opening. In another, a micrometer is used to measure from the upper surface of the nosebar vertically downward to the knife edge.

Discussions with veneer cutters who are acquainted with the instrument method have, in a general way, substantiated the above conclusions regarding the merits of the instrument method of setting their equipment. Machine operators who have become expert at operating their particular machines through years of experience, generally feel that they can get along well by using the "touch system," without the aid of instruments. Less experienced operators, or those who have had experience in using instruments, find the instrument method very useful in getting a good setup with a minimum of time and effort.

Discussion

Q.: Does the quality of the veneer —the lathe checks and the roughness —have an important effect on the quality of the plywood made from the veneer?

A.: Not only the knife checks and roughness, but also the uniformity of thickness may affect the quality of plywood. For best glue joints, veneer should be uniformly thick and smooth. Deep knife checks in face veneers may result in surface checking of plywood made with such veneers.

Q.: Do lathe operators generally know about the importance of the various settings on the machine?

A.: Years of experience are required to learn the best cutting techniques by trial and error methods. Unless operators have had a thorough training at the hands of experienced cutters, or have acquired a basic knowledge of the various factors through study of the few technical reports available on the subject, they may work at the trade for some years before acquiring a good understanding of the basic pinciples involved.

Q.: How would you go about setting up a quality control program so as to assure the cutting of good veneer at all times?

A.: Only very few mills exercise any appreciable degree of systematic control over the quality of veneer produced. For proper control, random samples of veneer should be taken at regular intervals at the lathe or slicer. These should be checked for thickness, smoothness, and depth of knife checks. Statistical quality control procedures should be applied to determine when the veneer deviates from established control limits.

Q.: Are there any specifications in existence as to what constitutes good veneer and what are the acceptable limits of roughness, checking, and uniformity of thickness?

A.: No. Specifications for aircraft plywood established during World War II set up certain requirements for veneer thickness. To the best of our knowledge, allowable limits for knife checking and roughness have not been established on the basis of sound, well-controlled tests.

Plywood Used in Containers

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Discusses the manufacture, properties, and specifications of plywood for containers, particularly for military use. Requirements of various types of plywood listed in military container specifications are analyzed and compared with similar grades from the Commercial Standards. General manufacturing processes and physical and mechanical properties of Douglas-fir plywood are reviewed.

PLYWOOD MAY BE DEFINED as a built-up panel consisting of an odd number of laminated veneers in which the grain of each piece is at right angles to the one adjacent to it. The kiln-dried veneer is united under high pressure with a bonding agent, so that the joint is as strong as the wood itself. It is manufactured from many species, both hardwood and softwood. This paper deals primarily with Douglas-fir plywood, except where other species are specifically mentioned.

Manufacture

Although details of manufacture may differ from mill to mill, and particularly for the various species, the basic manufacturing process consists of peeling or slicing the veneer, clipping, drying, patching, gluing and panel assembly, pressing, cutting to size, sanding, and final patching and grading. The manufacturing process permits variations in panel size, thickness, and construction, as well as in species and grade of the veneers and type of glue. These variables may all be governed by the proposed use of the panel and by manufacturing requirements.

Standard thicknesses for softwood plywood in general range from ¼ inch to ¾ inch, with others available on order. Standard panel sizes vary considerably, with widths generally ranging up to 48 inches, although 60-inch and even 72-inch wide panels are available from Douglas-fir plywood

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mills. Standard lengths generally range from 48 inches to 96 inches. Some fir plywood mills are equipped to make panels ranging up to 144 inches without scarfing equipment, while those which have scarfing equipment are capable of making panels of any length that can be shipped.

Plywood is manufactured by one of two basic types of process, hot press or cold press. The hot press process, which employs a heated platen multiopening press, must be used with phenolic resin glues to produce Exterior type plywood. Such glues may also be used in an extended form to produce Interior type plywood. The hot plate press may also be used in order to speed up the curing process with protein glues to produce Interior type plywood. The cold press process is used with protein glues and can produce a highly water-resistant, but not waterproof, glue bond.

The veneer used in commercial plywood is generally graded according to Commercial Standards, the grades being determined by the growth characteristics of the individual species and the market requirements. For example, Douglas-fir plywood is assembled from six separate veneer grades, hardwood plywood from four grades, and other Western softwood plywood from five or more grades. Specialty panels may require a separate grading of veneer.

General Properties of Plywood

Aside from the characteristics of the veneer used in its assembly, the properties of plywood come chiefly from its inherent cross-laminated construction. This construction utilizes the strength and stability of wood along the grain by laying alternate veneer sheets at right angles. Consequently, there is provided considerable strength both parallel with the grain and perpendicular to it, although the important gain in strength perpendicular involves some decrease in strength parallel to the grain.

The cross-lamination also provides important dimensional stability, since wood has very little expansion or contraction along the grain, even with large changes in moisture content and temperature. Furthermore, as the veneer is kiln-dried in manufacture, even the tendency to shrink has been largely removed.

Wood has no cleavage plane across the grain and consequently cannot split in that direction. For this reason, when wood is cross-laminated into plywood its resistance to splitting becomes extremely high.

In designing with plywood, its construction must be considered, since only those plies having their grain running parallel with the direction of applied load are considered as resisting direct stress. Thus, if plywood consisting of three plies of equal thickness is subjected to a tensile stress parallel with the two face plies, its strength is approximately two-thirds as great as though it were a solid piece of wood. If the load is applied perpendicular to the face plies, its strength is only one-third as great as the solid piece of wood, when the latter is loaded parallel with its grain, although it would be many times greater if the solid wood were loaded perpendicular to the grain.

Similarly, in bending or flexure, only the plies running parallel to the span are considered in most cases in computing the moment of inertia and the section modulus of the cross section.

In regard to shear there are two distinctive types to consider. One is that which occurs in a plane perpendicular to that of the panel; it is most readily visualized as being the horizontal shear occurring in a built-up beam having a plywood web. This shear through the panel thickness is computed over the full cross sectional area of the panel. Because of its resistance to splitting, the plywood in practice is appreciably stronger in shear than solid wood of the same species and grade.

The second type of shear is that which occurs in the plane of the plies. Such a shearing force subjects the wood fibers in those plies whose grain is at right angles to it to a rolling action. Resistance of plywood to this shear is less than that of wood parallel to the grain.

The matters of plywood strength properties, design methods, and allowable working stresses for various grades are covered more completely in References 5 and 8.

Properties for Container Use

One of the specific properties of plywood which is of most value when it is used in containers is the variety of thicknesses available. Because of this, the container may be designed to utilize the paneling material most efficiently so that no excess thickness is used. This may result in weight savings in many cases.

In addition, the large panel sizes that are available permit an important advantage. Except for the largest crates, it is generally possible to use a single piece of plywood for each side of the container. This not only saves labor and adds strength, but through elimination of joints reduces the likelihood of damage to the contents through pilferage or penetration of dirt and water. Because the large panel size permits all edges to be supported, danger of damage from concentrated loads is reduced.

Furthermore, an increase in resistance to racking is realized when the panel is attached along all four edges with no intermediate unspliced joints. This diaphragm action, in which the paneling material acts to resist distortion of the container, frequently permits reduction or omission altogether of diagonal bracing. The resistance to racking of the construction depends not only on the shear strength of the plywood, but also on the effectiveness of its attachment to the cleats which frame the container. Up to the point where the panel shears or buckles, the rigidity can be increased by increasing the number of nails. There are available design methods and allowable shears for plywood sheathed diaphragms with various nailing schedules, including a method for calculating their deflections (2, 4).[2]

Attachment of plywood with glue will provide a rigid box, but not necessarily one that will withstand the most punishment. Some tests have indicated that a box that is nailed only can absorb more energy than one that is glued (3).

Another desirable property of plywood is its high nail bearing strength. This arises primarily because of the resistance to splitting of even thin plywood. Large nails can be driven close to the edge of the sheet without breaking it out. However, the actual minimum edge distance that can be used without reducing bearing strength depends upon the nail size, the plywood thickness, species, and grain direction, as well as the direction of load with respect to the plywood edge. As an illustration of the latter factor consider, for example, 3/8 inch fir plywood nailed with an 8d common nail placed 3/8 inch from its edge, assuming that the lumber piece to which it is attached can develop the full strength of the nail. When the load is applied parallel with the edge of the plywood, its strength is 89%, while if the load is applied toward the edge of the plywood, its strength is 72% of the full possible nail bearing value. Further data on lateral nail bearing strength of Douglas fir plywood are given in Reference 6.

Another plywood property important to its use in containers may be termed plate action. This refers to the capacity of the panel to distribute loads normal to its own plane in both directions when supported on all four edges. Panels of the proportions normally encountered in containers can distribute significant amounts of applied flexural loads in directions both

[2] Numbers in parentheses refer to literature cited.

parallel and perpendicular to the face grain. The actual amounts distributed depend upon the construction of the panel, as well as the dimensions or spans between edge supports. Methods for structurally analyzing this plate action have been developed and are published in Reference 10.

Some test data are also available on the resistance of Douglas-fir plywood to concentrated or puncturing type loads; Reference 1 describes static tests giving deflections and ultimate loads applied to 1-inch and to 4-inch discs for various thicknesses of Douglas-fir plywood on spans ranging from 16 inches to 48 inches. These test data included the effect of normal defects permissible within a sheathing grade and occurring at random with respect to the load points.

In certain cases the resistance of plywood to moisture may be helpful in protecting the contents. For example, the vapor permeability of 5/16-inch Interior type Douglas-fir plywood is 1.8 perms,[3] while 3/8-inch Exterior type Douglas-fir plywood is 0.7 perms in the unfinished condition, and 0.16 perms when made with a high density overlay on each face. Use of this latter material may, under certain conditions, offer significant protection to the contents. However, to realize the benefits of this property, tight joints would be essential. For example, tests on a number of partially cleated plywood boxes (Style I, U.S. FPL Technical Bulletin No. 171) indicated that they would maintain their contents in a dry condition when floated in salt water for two weeks, or when exposed to a damp climate for nine months, provided they were made with sanded plywood and all joints were nail-glued.

Photos by U. S. Forest Products Laboratory

Household goods shipping container (top) for armed services, utilizing 3/8- and 5/8-inch Exterior type fir plywood with lumber cleats. These crates have made possible considerable economies in moving goods of military personnel. Crate knocked down (below) is strapped flat to base for return shipment. The unit is designed for fork lift handling in both positions.

Procurement

Most plywood for packaging purposes is procured under some type of specification. The specification may be federal or military in origin, calling either for flat panel or Container Grade plywood. In many instances, however, plywood for packaging is procured under the Commercial Standards for the industry, just as are the great majority of plywood purchases for other uses. These Commercial Standards represent the consensus of industry practice and of judgment regarding the most efficient utilization of material that will satisfy normal markets. They are promulgated by the U. S. Department of Commerce, with the advice of interested manufacturers and consumers. They are generally revised at irregular intervals, as determined by requirements of the interested parties and by changes in technology and manufacturing processes.

In general, there is little conflict between government specifications for flat panel plywood and industry practices, inasmuch as the former frequently incorporate the Commercial Standards directly. However, in the field of packaging, government specifications for Container Grade plywood have frequently been in conflict to some degree with the Commercial Standards. This has made for some confusion in procurement.

Such conflicts arise basically from the desire of the specifier for plywood that will be suitable for containers, and the desire of the plywood manufacturer to utilize his veneer most efficiently, and to avoid all possible confusion in his operation. The softwood plywood industry has considered it a needless refinement in container plywood to set up a veneer grade that is very similar to, but not quite identical with, an existing veneer grade that has been commonly produced for many years by all mills. Indeed, a number of mills have declined to produce Container Grade plywood as being relatively uneconomical. On the other hand, a number of mills have evidently found it desirable business, even though it may be a minor amount. Figures indicate that although large volumes of Douglas-fir plywood have been used for containers, actual "Container Grade" plywood has amounted to less than 1% of total Douglas-fir plywood production in the past few years. However, there appears to be a tendency for Container Grade plywood specifications to approach the Commercial Standards more closely in many respects.

Container Grade plywood is generally specified for government orders under one of two specifications. These are JAN–P–139, December 7, 1945, "Plywood, Container Grade," which has been superseded by Federal Specification NN–P–515, May 5, 1953, "Plywood, Container Grade." Although JAN–P–139 has been superseded, it is still referred to in various current specifications, such as MIL–C–6057. March 29, 1950, "General Specifications for Crates and Boxes; Aircraft and Airframe Component Parts," which was written before NN–P–515 came into force.

Since plywood for crating may be procured under other military or government specifications, it may be well

[3] A perm = 1 grain of moisture per sq. ft. per hour for a pressure of 1 inch of mercury.

Table 1.—PLYWOOD GLUE BOND REQUIREMENTS FROM CONTAINER SPECIFICATIONS AND COMMERCIAL STANDARDS

JAN-P-139	NN-P-515	CS35–49	CS45–55 and 122–49	CS157–49
Type A Weatherproof a. Boil–bake cycles without delam. b. Shear, psi: Under 250 Wd. Fail. Min. 30 Avg. 60; 250–350 Min. 10 Avg. 30; Over 350 Min. 10 Avg. 15	Type I Weatherproof Same as JAN-P-139	Technical and Type I a. Boil–bake cycle; also cold soak–dry cycle b. Shear, psi: Under 250 Wd. Fail. Min. 25 Avg. 50; 250–350 Min. 10 Avg. 30; Over 350 Min. 10 Avg. 15	Exterior a. Boil–bake cycle; also cold soak–dry cycle b. Avg. Wd. Fail. = 80% c. Fire Delam. Test	
Type B Spec.-Moist.-Resistant 10 cycles soak and dry with 80% passing.	Type II Spec.-Moist.-Resistant Same as JAN-P-139, but 90% passing on retest.	*	Interior 15 cycles soak and dry; average passing 10 cycles. 85% specimens passing 3 cycles (in CS45 only).	Moist.-Resistant Interior 10 cycles soak and dry with 100% passing.
Type C Weather-Resistant 2 cycles soak and dry with 100% passing.	Type III Weather-Resistant Same as JAN-P-139	Type II 2 cycles soak and dry with 80% passing.		
	Type IV Non-Moist.-Resistant No Test	Type III* No Test		

*CS35–55 will add a ten-cycle type and delete the dry-bond types.

to mention those for general purpose plywood that are fairly recent. Such specifications include JAN–P–66, September 22, 1944, "Plywood, Flat Panel" now obsolete. It was succeeded by MIL–P–66A, December 27, 1949, "Plywood, Flat Panel" and Amendment I, January 9, 1952. Both of these specifications generally follow the Commercial Standards fairly closely. MIL–P–66A also included provisions for a special grade, called Marine plywood, which designation was later changed to Boat Hull grade plywood in the Amendment. It also provided for fire retardant treatment.

A later specification, MIL–P–0066B, July 20, 1953, "Plywood, Flat Panel; For Boat and Ship Construction," was prepared by the Bureau of Ships for use in procurement in plywood specifically for shipbuilding purposes. It included provisions for Commercial Standard Douglas-fir plywood, as well as for a special grade of Boat Hull plywood including both mahogany and Douglas-fir. Preservative and fire-retardant treatments were also covered. It is understood that this specification is in the process of revision so as to take the place of those parts of MIL–P–66A with which it overlaps. Until MIL–P–0066B is revised, MIL–P–66A will remain in force.

A recently issued Federal Specification, NN–P–530, March 1, 1955, "Plywood, Flat Panel," has superseded those portions of MIL–P–66A which deal with commercial grades of plywood. This new specification refers directly to the applicable Commercial Standards.

There are four Commercial Standards under which plywood is produced. CS35–49 governs the manufacture of hardwood plywood, CS45–55 covers Douglas-fir, including overlaid plywood, CS122–49 covers other Western softwood species, except that ponderosa and sugar pine are manufactured under CS157–49. (In the terminology of the Commercial Standards, the first numbers designate the type of commodity, while the second numbers designate the year of promulgation of that standard. For example at the time of writing, CS35–49 is being revised to CS35–55).

Comparison of Commercial Standards and Container Specifications

The important factors relating to plywood manufacture covered by both the Commercial Standards and the container specifications include type of glue bond and grade of veneer. Other miscellaneous manufacturing details are also covered, such as size tolerances and moisture content.

Types of glue are specified according to their relative durability under exposure. These are classified in Table 1 for both Container Grade specifications and the Commercial Standards. There are four types of bond provided for in NN–P–515, the current Container Grade specification. For convenience these four types might be called waterproof, ten-cycle, two-cycle, and dry bond. Then JAN–P–139 provides for only the first three of these, as will CS35, when revised, while CS45 and CS122 for only the two highest. CS157 specifies only the ten-cycle type.

Waterproof Bond: A comparison of requirements for the waterproof type shows that all the specifications require that shear specimens pass a boil–bake–boil cycle without delamination. The Commercial Standards require in addition a cold soak and drying cycle without delamination. Both NN–P–515 and JAN–P–139 permit wood failure of the shear specimens to be based on a sliding scale, decreasing as the shear strength increases, with an average of 60% wood failure when the shear strength is less than 250 psi. CS45–55 and CS122–49 require an average wood failure of 80%, with additional limitations on minimum values. This requirement has been based upon the correlation of laboratory tests with thousands of exposure wall specimens and has been well documented. (11).

The requirements under CS35 for Technical and Type I plywood are similar to those for the container specifications, being based on a sliding scale, with the exception that an average wood failure of 50% is required when the shear strength is less than 250 psi.

There is an additional requirement in NN–P–515, Section 3.5.4, requiring Type I plywood to be assembled with resin glues containing no inert filler in excess of 20% by weight of the dry resin. It has been pointed out that many of the glues used in CS45 and CS122 Exterior type plywood (which exceeds the performance requirements of NN–P–515, Type I) contain as much as 40–50% inert filler. Furthermore, such glues are not subject to mold attack. It would appear that this requirement, if rigidly enforced, might preclude the use of CS45 Exterior type plywood and

others of demonstrated adequacy under this specification, even though their actual performance is considerably higher than called for. It is understood that Section 3.5.4 is being revised to eliminate this conflicting requirement.

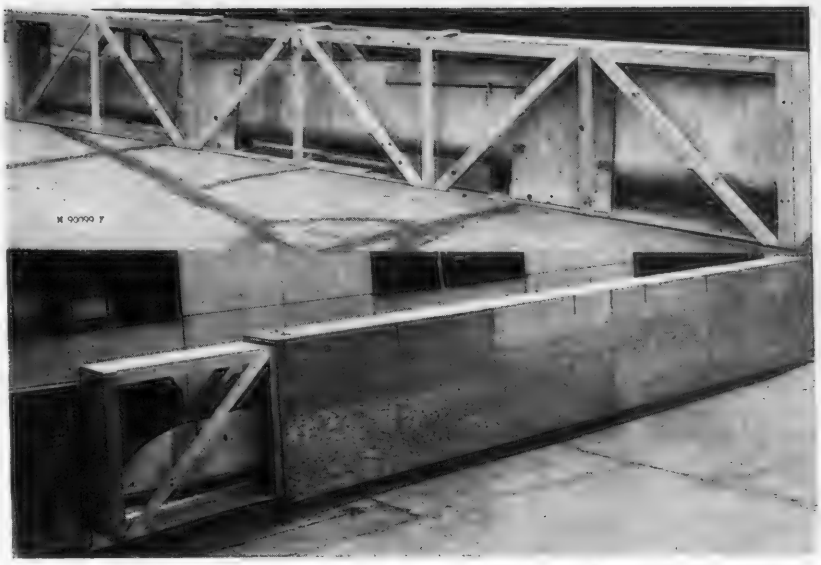
It is worth noting that the softwood plywood industry's high performance requirement for wood failure in Exterior type plywood appears to have been confirmed by the other Military Specifications. MIL–P–66A requires that all Boat Hull grade plywood, regardless of species, conform with the Exterior type bond, as given in CS45. Likewise, in MIL–P–0066B the Bureau of Ships specifies the CS45 Exterior requirements for both the hardwood and softwood species listed.

Ten-Cycle Bond: The ten-cycle plywood labeled Special moisture-resistant in the container specifications (Type B in JAN–P–139 and Type II in NN–P–515) is required to pass ten cycles of soaking and drying at normal room temperature. The test is similar for CS45, –122 and –157 plywood, while this type is not called for under CS35–49, but will be for CS35–55. Requirements for passing vary somewhat within these specifications, but CS157 requires that 100% of the specimens pass the ten-cycle soaking and drying test. JAN–P–139 and CS35–55 require 80% of the specimens to pass the ten cycles. CS45 provides for the test to run for fifteen cycles, with specimens passing an average of ten cycles, plus an additional important requirement that at least 85% of the specimens shall withstand three cycles. The net effect of this test requirement is that Interior type plywood which will meet the quality of CS45 (and 122) will normally exceed the quality specified as Type B under JAN–P–139.

There has been much confusion regarding a paragraph of NN–P–515 on testing of Type II plywood. When interpreted literally, Paragraph 3.5.2 would probably result in the rejection of most top quality Commercial Standard Interior type plywood. This section apparently requires all but one specimen of the entire test to pass the full ten cycles, whereas the intent was to require only 80% passing.

This has been confirmed in a letter to the Douglas Fir Plywood Association from the Corps of Engineers, St. Louis district, which advised that in future purchases the wording would be suitably altered.

When this change appears in writing on purchases made under this specification, then Type II plywood will require only 80% of the panels to pass the ten-cycle test, although 90% of any re-test specimens are required to pass. Thus normal CS45 and 122 Interior type plywood should qualify under these requirements.



Photos by U. S. Forest Products Laboratory

Re-usable two-way shipping container for aircraft control surfaces. Developed at U. S. Forest Products Laboratory, these crates are adaptable to both air and surface shipment for items weighing up to 1 ton. Inner container (top) utilizes fir plywood in ends and supporting cradles and may be used for air shipment. Outer container (below) is plywood sheathed crate which slips over inner crate for additional protection required for surface shipment.

Two-Cycle and Dry Bond: A two-cycle plywood is specified as Type C, Weather-resistant, under JAN–P–139, and Type III, Weather-resistant under NN–P–515. Requirements for this type consist of two cycles of soaking and drying at normal room temperature with 100% of the specimens passing the two-cycle test. Type II plywood produced under CS35–49 requires a two-cycle test with 80% passing.

Type IV plywood under NN–P–515, which is called Non-moisture-resistant, requires no test and is not expected to withstand any exposure to rain or other moist conditions. Type III plywood made under CS35–49 also has no test requirements. This type is to be dropped when CS35–55 is adopted.

Toxic in Glue

Because containers may be subjected to conditions conducive to mold growth in the plywood glueline, the container specifications call for addition of a toxic to the glue mix for certain formulations (except for Type IV under NN–P–515). The requirement is usually for 5% of chlorinated phenols or their sodium salts.

However, since JAN–P–139 was issued, there have been developed hot press protein glues containing a small percentage of phenolic resin which have mold resistance equal or superior to that obtained by the addition of 5% of toxic to a regular protein glue. These glues are commonly used in the fir plywood industry where a mold resistant glue bond is specified for certain grades under CS45. Accordingly, NN–P–515 permits the manufacturer to certify that the glue used in Types II and III plywood is mold resistant, in lieu of requiring the addition of the 5% toxic.

A simple flame test may be used to determine qualitatively the presence of chlorinated phenols in a protein glueline. It should be noted from the above data, however, that lack of such chlorinated phenols does not necessarily indicate that the glueline lacks mold resistance, as an extended phenolic resin or a hot press protein glueline incorporating a small amount of phenolic resin can also qualify. Also, if the plywood has been treated with a toxic water repellent, the flame test may indicate only the presence of chlorinated phenols in the water repellent. The test is performed by cleaning a coiled copper wire in a hot flame, such as that of a Bunsen burner, placing the sample of plywood containing a fairly large portion of exposed adhesive in the coil, and igniting it over the flame. A bright green flame indicates the presence of a chlorinated product.

Water Repellent Preservative

When specified as Class II, plywood under Specification NN–P–515 requires surface treatment with a water-repellent preservative. When Class I is specified, no surface treatment is required. Under JAN–P–139,

Table 2.—PLYWOOD VENEER QUALIFICATIONS AND WORKMANSHIP REQUIREMENTS FROM CONTAINER SPECIFICATIONS AND COMMERCIAL STANDARDS

Maximum Permissible Defects	NN-P-515* Federal Container Plywood		CS35-49 Hardwood Grade 4	CS45-55 and 122-49 Douglas-fir and Western Softwoods Grade D
	Faces	Inner Plies		
Holes	2½"; (4" total in 12" circle)†	Same as faces†	1½"§ (3" total in 12" square)	2½"
Knots	3" (6" total in 12" circle)	Same as faces†	Yes	Yes
Shims, plugs, patches	Yes	Same as faces†	Yes	Yes
Worm or borer holes	2" across grain	Same as faces†	Yes	Yes
Pitch or bark pockets	1"x3" to glue	Same as faces†	Yes	2"x4"
Decay	No	Same as faces†	Yes§	No
Tape	Yes	No	Faces only, not allowed in inner plies of Types II and III	Faces only
Laps	No	1" (Spaced 24" or more when over ½")	No	No
Splits, gaps, open joints	3/8" (Full panel length)	½" (Space 24" or more when over ¼")	¼" (Full length)§	3/8" (Full length)‡ ½" (Quarter length)

*JAN-P-139 requirements are the same as NN-P-515, except that former permits 2" maximum knotholes and tape in glueline.

†Additional requirements govern number and location of knots and holes with respect to superposition and panel edge.

‡Splits must taper to a point. Core gaps not limited.

§CS35-55 will permit 2" holes, and will not permit decay. Holes may total 4" in 12" square, and splits may be up to 1" wide for quarter panel length.

surface treatment is indicated where Condition I plywood is specified, while untreated surfaces are called for under Condition II.

The toxic water repellent called for under JAN–P–139 is required to conform with AN–P–76, June 12, 1945, "Preservative; Water Repellent." The number of this specification was changed to MIL–P–7000, September 5, 1950, without any other change. Under NN–P–515 the applicable water-repellent specification is TT–W–572, February 29, 1952, "Wood Preservative, Water Repellent."

In the case of AN–P–76, or MIL–P–7000, the toxic material consists of 5% of pentachlorophenol or mixtures of the chlorinated phenols. Under TT–W–572, the toxic material consists of 5% of straight pentachlorophenol, although provision is made for the alternate use of copper napthenate. Both specifications require a definite degree of water repellency in addition to the toxic requirements. Coverage is specified at the rate of 2.2 lbs. per hundred sq. ft., which, considering the weight of the normal water repellent, is approximately 3 gal. per thousand sq. ft. Such coverage is readily obtained by the conventional flood applicators used in most fir plywood mills.

Treatment of protein-glued Interior type fir plywood with such water repellent preservatives in a mill flood applicator definitely increases the resistance of the panel to delamination, both under soaking and drying cycles, and under exposure to high humidities favoring mold development. Laboratory tests (7, 9) showed the effectiveness of the solutions in retarding delamination to be related to their water repellency ratings. Good water repellents, conforming to TT–W–572, nearly doubled the cyclic delamination resistance of protein glued plywood, and tripled its resistance to mold.

Veneer Grades

With the qualifications noted above, production of Container Grade plywood can be achieved by the normal fir plywood mill without altering routine procedures. However, the grade of the veneer, as mentioned previously, requires a classification separate from the ordinary Commercial Standard grade. By way of comparison, Table 2 shows the principal requirements for NN–P–515 Container Grade and for certain Commercial Standard grades of veneer. The requirements for JAN–P–139 are similar to those for NN–P–515 with the exception that JAN–P–139 permits only 2-inch knotholes. (Also tape is permitted in the glueline under JAN–P–139.)

The increase in permissible knothole size to 2-½ inches made under NN–P–515 has removed a primary objection to this specification by the manufacturers of Douglas fir and Western softwood plywood, as this size knothole coincides with the maximum limit set for D grade veneer under CS45 and 122. The other restrictions in NN–P–515 regarding size of knots and permissible defects within a 12-inch circle cause little or no difficulty with normal D grade veneer. The same holds true of permissible sizes of worm or borer holes, as well as pitch or bark pockets.

The requirements for splits, gaps and open joints differ between NN–P–515 and CS45. The former permits gaps up to 3/16 inch in the faces, while those in the inner plies can range up to ½ inch with limitations on their frequency. In CS45 D grade veneer splits are limited, but have the additional requirement of tapering to a point at one end. The maximum width of 3/16 inch is permitted for those which run the full panel length, while those which are ½ inch wide must run no more than ¼ the panel length. Although core gaps are not specifically limited, normal production will have no difficulty in conforming with the requirements of NN–P–515. Core laps, permitted by NN–P–515, are strictly prohibited, even in unsanded panels, from all CS45 and 122 production.

Both JAN–P–139 and NN–P–515 contain additional requirements regarding the location of knots and knotholes at the edges of the panel, apparently based on nailing of the containers. Such requirements might be placed more logically in the specification for manufacture of the individual container, as there is no assurance that, once the panel is cut up, the new edges will be free of such defects.

It is evident that D veneer under CS45 and CS122 can, with very minor modifications, be made to conform with NNP–515. However, the additional requirements of the latter must, of course, be kept in mind when selecting D grade veneer and laying it up for this specification.

A similar observation can be made with respect to Grade 4 veneer under CS35–49, although it permits a maximum knothole size of 1-½ inches (2 inches in CS35–55). In other respects it appears to conform rather closely with NN–P–515, with the exception that CS35–49 permits decay, which is forbidden under NN–P–515 and CS35–55.

Under CS157 the Commercial Standard grade which possibly comes closest to conforming with NN–P–515 is listed as Sheathing Face. This permits not more than ten knotholes of maximum 1-½-inch diameter, no splits wider than ¼ inch nor open pitch pockets more than 1 inch wide. Repairs are permissible but other defects are not specified.

Other Requirements

Miscellaneous requirements for NN–P–515 plywood include a moisture content ranging from 5% to 18% when shipped, based on oven-dry weight. This represents a change from JAN–P–139, which permitted a range from 7% to 18%. CS45 permits a maxmum moisture content of 18% with no minimum. The other Commercial Standards do not specify moisture content.

Dimensional tolerances for Commercial Standard plywood are as close

or closer than those of the container specifications.

In summary, plywood possesses some excellent qualities that make it particularly suitable for use in containers. Container Grade plywood, although differing to a small degree from regular Commercial Standard grades, can nevertheless be obtained with only minor modifications of normal production procedures.

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Choosing a Hardwood Lumber Grade for Furniture Manufacture[1]

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Higher grades of hardwood lumber are becoming scarce and furniture manufacturers must meet part of their lumber requirements from low grades formerly considered too costly to process. This report analyzes factors which affect the relationship between lumber quality and conversion cost. It shows that under present manufacturing systems, it is possible to process low-grade lumber into required cuttings at a lower net unit cost than high grades.

THE ANNUAL CONSUMPTION of hardwood lumber by furniture plants in the United States exceeds 1.5 billion board feet, valued at approximately $200 million. In spite of this high consumption, little information is available on what lumber grades should be used to manufacture specific articles at the lowest possible unit cost. This is because factors which affect the relationship between lumber quality and conversion cost are inadequately understood. The purpose of this report is to analyze these factors in order to establish relationships between lumber quality and labor and material costs. Once established, these relationships may be used to indicate which lumber grades would produce cuttings of different sizes at the lowest possible cost.

Management in furniture plants is well aware of the relationship between direct labor and direct material costs. It is also aware that manufacturing costs are higher for parts made from low quality lumber than from high. In many cases, however, management knows the relationship between lumber grades and the yields that may be obtained from them only on a theoretical basis as described in the yield studies, defined in the grading rules, or on an average basis expressed by the waste factors which apply to the lumber converted in any particular plant. Accurate determination of the relative material costs between grades has been made in only a few plants, and nothing has been done to find the direct labor cost differences between lumber grades for manufacturing cuttings of different sizes.

The importance of yield is so well recognized that management in every furniture plant considers the increase in net yield and the resulting decrease in waste to be of vital interest. These factors, however, are known only on an average per net foot basis. In planning efficient factory operation for low unit cost production, it would be much more effective to have a cost breakdown by cutting size and lumber grade.

The importance to the hardwood furniture industry of planning for efficient production by the use of precise information on the yields and costs of cuttings produced from lumber of different grades is enhanced by the progressive depletion in the quality of the lumber supply. The higher grades of lumber are becoming increasingly hard to get. Ellertson and Lane (3),[3] after a study based on 390,000 board feet of hardwood lumber in the Tennessee Valley, report only 37 per cent of yellow poplar and 28 per cent of other hardwoods to be above No. 2 Common. Gevorkiantz and Scholz (4) report only 29 per cent above No. 2 Common for red oak from southwestern Wisconsin.

The hardwood furniture industry is traditionally a consumer of the higher lumber grades. This was perhaps justifiable when virgin forests and high quality lumber were plentiful, and when considerable handwork was required to convert lumber to pieces of the required sizes. At that time, drying was a relatively long process, so large quantities of lumber were inventoried to assure future supplies. The handling and transporting of lumber was more difficult and time consuming. Under such conditions, the use of high grades, i.e., No. 1 Common or better, was possibly most economical. These grades have continued in high favor, although the conditions which originally may have favored their use no longer exist. The furniture industry generally has failed to realize that because of technological

[1] Second in a series of three contributed papers on the relationship between lumber grade and conversion cost in furniture plant rough mills.

[2] Studies were conducted at Baker Furniture, Inc. while the author was on the Michigan State U. faculty.

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[3] Numbers in parentheses refer to literature cited.

Table 1.—PRIME COST PER NET FOOT FOR ONE-INCH YELLOW POPLAR CUT TO THREE-INCH WIDTHS AT PLANT A*

Lumber Grade	Cost Item	Cost, dollars† Cutting Length, Inches 12	24	36	48	60	72
Firsts and Seconds	Cross-cut	$0.0090	$0.0057	$0.0045	$0.0040	$0.0036	$0.0034
	Rip	.0204	.0112	.0091	.0087	.0088	.0090
	Material	.3103	.3103	.3103	.3103	.3103	.3103
	Total	.3397	.3272	.3239	.3230	.3227	.3227
Saps	Cross-cut	.0125	.0077	.0061	.0053	.0049	.0045
	Rip	.0239	.0135	.0110	.0107	.0108	.0110
	Material	.3188	.3188	.3188	.3188	.3188	.3188
	Total	.3552	.3400	.3359	.3348	.3345	.3343
Number One Common	Cross-cut	.0150	.0096	.0079	.0069	.0064	.0060
	Rip	.0317	.0189	.0156	.0145	.0142	.0144
	Material	.2801	.2801	.2801	.2801	.2801	.2801
	Total	.3268	.3086	.3036	.3015	.3007	.3005
Number Two A	Cross-cut	.0196	.0143	.0105	.0093	.0087	.0082
	Rip	.0397	.0232	.0196	.0185	.0182	.0185
	Material	.2403	.2403	.2403	.2403	.2403	.2403
	Total	$0.2996	$0.2778	$0.2704	$0.2681	$0.2672	$0.2670

*Labor cost differences between the grades are caused by:
a. More cuts are required to remove defects from low-grade boards.
b. Low-grade boards are more difficult to "size-up". Hence, they require more turning over and examination.
c. Handling low-grade lumber to the machines is more costly per net foot because of the lower yield per cent.
d. Operations performed on low-grade boards are less productive than those performed on higher grades because of the smaller average size.
†Costs shown are from Creighton (1) and are based on time studies of rough mill operations.

improvements, the total cost for parts made from the low grades may be less than for those made from high grades, without a sacrifice of quality.

Lumber Grade as a Measure of Quality

It is necessary to understand the lumber grades and their relationship to quality in order to make any comparison between them. Different lumber grades should be considered as entirely different materials. Each lumber grade has characteristics which fit it for specific purposes, just as different sizes and shapes of steel are suitable for different purposes.

A point not clearly understood by many people in the woodworking industries is that the rules for measurement and inspection of hardwood lumber define the grades principally on the basis of the percentage of clear lumber in a board. Given boards of equal size, those in the high grades will have more clear wood than those in the low. With few exceptions, the clear pieces that are cut out of the low-grade boards are smaller, but otherwise just as good as those cut from the high.

For example, Firsts and Seconds boards[4] with 10 board feet must have almost 9 board feet of clear usable lumber, whereas a No. 2 Common board of the same size need have only 5 feet of clear lumber. The remaining 5 feet would contain all the defective parts which cause the board to be graded down to No. 2 Common. For this reason, once the clear cuttings are produced, they are of equal quality no matter from what lumber grade they are obtained. The clear cutting, then, might be considered as the product of the rough mill. Lumber quality as expressed by lumber grades will not affect the quality of cuttings beyond this point.

[4]For complete definitions of the lumber grades, refer to the rules for measurements and inspection of hardwood lumber (6).

Rough Mill Procedure

The sequence of operations in different rough mills varies, but normally the sequence for breaking boards down to required cutting sizes is as follows:

1. Cross-cut the boards to required cutting lengths.
2. Plane one face on the face planer.
3. Pass the stock through a single surfacer to plane the back face.
4. Joint both edges.
5. Rip the stock to required cutting widths, or to pieces which will be glued to make the required widths.
6. Glue to required widths.
7. Plane to required thickness.

All stock normally proceeds through steps 1 to 5. Some finished cuttings might result after ripping and go directly to a machine room for further machining. Other pieces might skip step 6 and emerge from the planer as finished cuttings. Still other pieces might be complete cuttings right after gluing.

Operations following rip sawing normally would have no bearing on the effect of lumber grade on the cost of procuring cuttings, for defects will have been removed by the time ripping is completed. However, when glue lines are permitted in the cuttings there is a possibility that more gluing would be required for cuttings from lower grades. This is because of the small average size of pieces cut from such grades.

The cost of planing glued-up stock may also vary between grades because of the difference in the number of glued up pieces. It is more difficult for the planer operator to feed the planer from a pile in which stickers separate the courses of stock and in which the glue squeezed out from the joints tends to bind the stickers to the stock.

A study was conducted in three furniture plants, designated as A, B, and C. In plant A, the cut-off saw, face planer, single surfacer and double-edge jointer are connected by conveyors. Two men operate the entire line. Edge gluing is performed on a high-frequency press. In plants B and C, all machines are hand operated and edge-gluing is done by hand operated clamp carriers.

Determination of Direct Labor Cost

In this report the material cost is based upon the usable portion of lumber which results in finished cuttings. The unit of measure is the yield foot, or the net foot as it is more commonly termed in wood working industries. This is not a cubic measure, but is the surface measure of the piece in square feet multiplied by the rough thickness of the original stock in inches.[5] If the original cost and yield are known, it is not difficult to determine the material cost per net foot.

Direct labor cost is dependent upon time per net foot and can be determined if times of the various rough mill operations are found and related to the yield of clear cuttings. The methods used to make the time studies and convert time to labor cost are described by Creighton (2).

The labor rates used are not those from any of the plants. They are given here only for illustration purposes, and any other set of rates could be applied. If the rate for machine operators is assumed to be $1.75 and for helpers $1.50 per hour, the labor cost per minute would be $0.07917 for a process with an operator and two helpers, $0.5417 for an operator and one helper, and $0.2917 for an operator working alone. Direct labor costs per net foot based upon these rates are given in Table 1 for several cutting sizes cut from four grades of one-inch Yellow Poplar at plant A. Table 3 shows direct labor costs to manufacture one inch hard maple cuttings twenty-four inches long and four inches wide at plants A, B and C.

[5] Exception is made when a finished thickness is obtained from a rough thickness that is greater than needed. The normal rough thickness required to make the piece is used to determine the net footage.

Direct Material Cost

By far the greatest element of cost for the finished cutting is the direct material cost. In Plant A, the rough mill working at capacity might produce from 2,000 to 5,000 net feet per day depending upon the lumber grade being cut and the cuttings required. If the total daily production is 2,000 net feet, the total direct labor cost, at $4.75 per hour for the cut-off saw and conveyorized surfacing line, and $3.24 for each of the two rip saws, would be $90. 3,000 board feet of No. One Common one-inch yellow poplar lumber, costing $414, would be required to yield the 2,000 feet of finished cuttings.

The purchase price is not the total cost which the material must bear. In transit from the supplier, the lumber has picked up some freight cost. In being unloaded at the furniture plant and being stored and handled in the yard, it has picked up a handling cost. In being dried to the desired moisture content, it has picked up a drying cost, or kiln cost. In addition, the lumber has lost size through shrinkage, and suffered some degrade. These costs must be borne by the lumber at the time it reaches the rough mill. To be readily usable for making comparisons, the costs should be expressed in terms of cost per net foot, as is direct labor cost.

Hardwood lumber prices used in this report to determine the direct material cost per net foot were taken from the Appalachian hardwoods section of the *Hardwood Market Report*, dated October 10, 1953 (4). They are shown in Table 2. Average net yield percentages of rough lumber footage in lengths above 12 inches for one-inch yellow poplar grades are: Firsts and Seconds, 86.0 per cent; Saps, 77.1 per cent; No. 1 Common, 68.2 per cent, and No. 2 A Common, 57.6 per cent.

Kiln drying costs furnished by the Lumber Drying Specialty Co., Grand Rapids, Mich., are considered to be representative of kiln drying costs. They are used in this report to determine yellow poplar and hard maple material costs. A 5% reduction from green lumber footage was made on all grades and species to allow for shrinkage and drying.[6]

Handling and moving lumber in the yard costs an average $2.50 per 1,000 board feet at Plant A. Freight costs at Plant A averaged approximately $25 per 1,000 board feet for yellow poplar and $30 for other hardwoods over a six months' period. These costs are used to determine total material costs.

[6] The allowance for 5% shrinkage is based on a test in which 2,263 board feet of 1-inch hard maple was dried from an average moisture content of 35% to 6%. The board footage after kiln drying was 2,149—a reduction of 5% from the original footage.

Table 2.—LUMBER COST PER NET FOOT

Description	Lumber Grade				
	FAS	Selects	Saps	No. 1 Com.	No. 2* Com.
	One-inch Yellow Poplar				
Rough footage	1000.00	----------	1000.00	1000.00	1000.00
Less 5% Shrinkage	950.00	----------	950.00	950.00	950.00
Yield %	86.00	----------	77.10	68.20	57.60
Net Footage	817.00	----------	732.50	647.90	547.20
Material Cost					
Price per M.b.m. F.O.B. mill†	$210.00	----------	$190.00	$138.00	$ 88.00
Kiln drying	16.00	----------	16.00	16.00	16.00
Yard handling	2.50	----------	2.50	2.50	2.50
Freight	25.00	----------	25.00	25.00	25.00
Total	$253.50	----------	$233.50	$181.50	$131.50
Cost per net foot	$ 0.3103	----------	$ 0.3188	$ 0.2801	$ 0.2403
	One-inch Hard Maple				
Total Material Cost	$255.50	$245.50	----------	$185.50	$130.50
Cost per net foot	0.3106	0.3446	----------	0.2918	0.2497

*No. 2A Common in Yellow Poplar.
†Lumber prices from **Hardwood Market Report** (4).

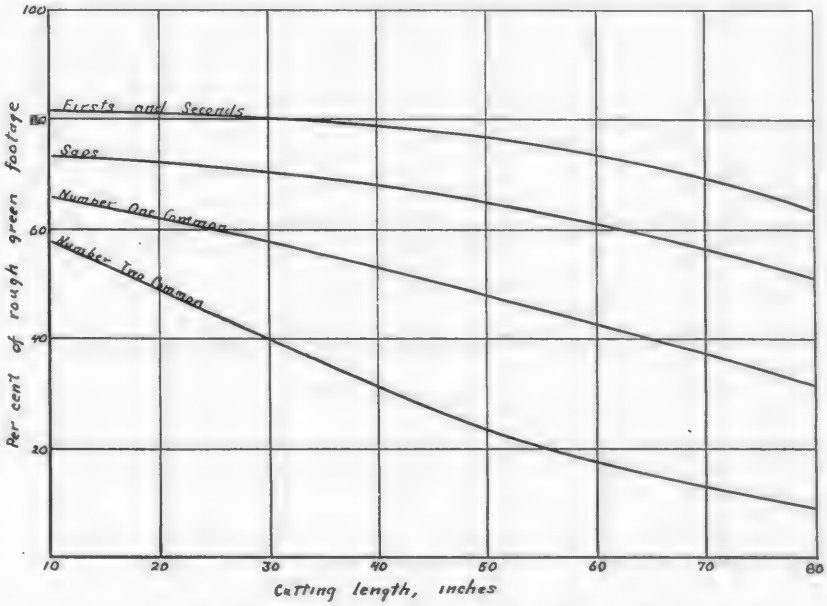

Fig. 1.—Cumulative yield per cent of green rough lumber footage for one-inch yellow poplar at Plant A. Taken from yields reported at left, reduced by 5 per cent to allow for shrinkage.

Table 2 shows the determination of direct material cost per net foot for 1-inch yellow poplar. Total direct labor and material cost may now be found by summing up material costs, Table 2, with the direct labor costs as given in Table 1, in order to obtain the prime cost for one-inch yellow poplar.

It is evident from Table 1 that as long as the cutting sizes could be obtained from each of the grades, No. 2 A Common will yield required cuttings at the lowest unit cost, No. 1 Common is the next in cost, followed by Firsts and Seconds, and Saps. This is in direct contrast to the normal buying policy of plant A, which had heretofore purchased No. 1 Common and better lumber with a high percentage of Saps and Firsts and Seconds.

Even though Table 1 shows that cuttings could have been produced more economically from the No. 2 A Common grade, requirements for large cuttings may sometimes be so high that they cannot be obtained from that grade, nor even from No. 1 Common. In that case, a certain percentage of higher grades of lumber will be required.

Costs with Incomplete Lumber Utilization

The direct labor and material costs developed to this point have been based upon a breakdown of the board to cuttings of specific sizes with an assumption that full utilization is made of all sizes into which the lumber might be cut. Because of the number of defects allowed in lower lumber grades, and the small clear faced cuttings permissible in them, it is difficult to obtain a high yield of long cuttings. Therefore if a group of bills calls for cuttings of long lengths,

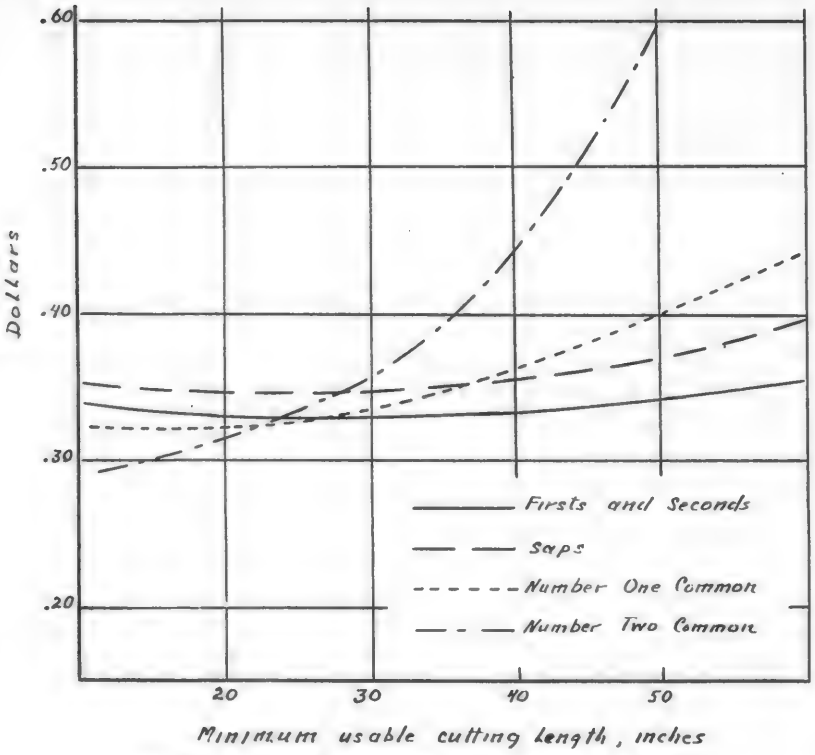

Fig. 2.—Prime cost per net foot for different minimum cutting lengths of one-inch yellow poplar at Plant A.

and there is no immediate use for the short lengths which more normally fit into the grade, the net yield of long cuttings from the No. 2 A Common grade might be so low as to make it profitable to use a higher grade of lumber. It is necessary, therefore, to know approximately what yields can be expected in each cutting length from each grade.

This subject is treated by White (8) and Noltemeyer (7), but the method used to obtain information in plant A was that described by Creighton, Stump and Hutchins (1). The study was conducted using 5,402 board feet of 1-inch yellow poplar to determine the yields in different cutting sizes. Grades were distributed as follows: Firsts and Seconds, 1,326 board feet; Saps, 1,020 board feet; No. 1 Common, 1,008 board feet; and No. 2 A Common, 2,048 board feet.[7] Figure 1 shows cumulative yield per cent of green rough footage for 1-inch yellow poplar at plant A. Percentages taken from these curves may be used to estimate the percentage of rough lumber footage which is available in each grade for cuttings of different lengths.

The curves in Figure 1 may be used to estimate cost per net foot of long cuttings when the short ones cannot be used. For example, the cost per net foot of 36-inch and longer cuttings from each of the yellow poplar grades is derived as follows:

	FAS	Saps	No. 1 Com.	No. 2A Com.
Net yield per cent from Fig. 1	79.5	69.2	55.5	35.0
Yield per rough M.b.m.	795.00	692.00	555.00	350.00
Cost per M. from Table 2.	$253.50	$233.50	$181.50	$131.50
Cost per net foot	.3189	.3374	.3270	.3757
Direct labor, cut-off from Table 1	.0045	.0061	.0079	.0105
Direct labor, ripping from Table 1	.0091	.0110	.0156	.0196
Total cost per net foot	.3325	.3545	.3505	.4058
Cost per M.b.m. Net footage	$332.50	$354.50	$350.50	$405.80

Clearly, the Firsts and Seconds grade will yield the cuttings at the lowest cost.

If costs per net foot for other minimum usable lengths are similarly computed and plotted, the curves presented in Figure 2 will result. Figure 2 may be interpreted as follows:

1. That the saps grade, as used in plant A, is more costly than other grades when a minimum cutting length is below 28 inches; that it is less costly than No. 2 A Common above 28 inches; that it is less costly than No. 1 Common when minimum lengths are above 38 inches; and that it is never as cheap as Firsts and Seconds.
2. That when utilization can be obtained in lengths below 24 inches, No. 2 A Common is the most economical and No. 1 Common next.
3. That when 27-inch and longer lengths are required, the Firsts and Seconds grade is the most economical.
4. That a mixture of grades might yield cuttings at a lower overall cost than any single grade. For instance, the Firsts and Seconds grade might be used to cut bills calling for predominantly long cuttings, and a lower grade used for bills calling for short ones.

The problem of wide widths is not so serious. Normally wide widths may be obtained by gluing the narrow ones. Large clear pieces without joints are usually obtained by laminating veneers. For this reason, furniture plant requirements for excessively wide solid cuttings are not great.

Effect of Process Changes on Choice of Lumber Grade

The direct labor cost is normally such a small part of prime cost that a minor process change would have no effect upon the choice of lumber grade. However, when changes such as the conveyorizing of a rough mill are made, the direct labor costs might be changed to the extent that the cost advantage will change from one grade to another. This illustrated by a comparison between plant A with its conveyorized line, and plants B and C. Direct labor and material costs for processing 1-inch hard maple to cuttings 2 feet long and 3 inches wide are shown in Table 3. In all three plants, cuttings derived from No. 2 Common lumber are lower in cost than those from other grades. In plant A, the Firsts and Seconds grade is most costly. No. 1 Common is most costly in plants B and C.

Table 3 also shows the value of the conveyorized rough mill in plant A. The prime cost of cuttings from every grade is lower than that from any grade in plants B and C.

Summary

The quality of lumber from which furniture is made is progressively deteriorating. Furniture manufacturers are forced to meet at least part of their

[7] The sample is not considered to be adequate to give an accurate estimate of expected yield percentages. It is used here for illustrative purposes.

lumber requirements from low grades which were formerly considered too defective and too costly to process. This report shows that under present manufacturing systems, it is possible to process the low grades into required cuttings at a lower net unit cost than the high grades.

Material and labor direct cost relationships between cuttings of different sizes from different lumber grades are shown. The use of cost data to determine the proper lumber grade to choose for low unit cost production is illustrated.

The effect upon cost of cutting requirements which result in incomplete utilization of small sizes is also developed. Results show that cuttings made from the lower grades are normally lower in cost, but that when cuttings below 30 inches in length cannot be completely utilized, cuttings from the lower grades are excessively high in cost.

This report also shows that the use of more efficient processes tends to reduce the prime cost of cuttings produced in a rough mill. It shows that when process changes are made, conditions determining cost might be so affected as to change the cost advantage from one grade to another.

Table 3.—COMPARISON OF ONE-INCH HARD MAPLE PRIME COST IN THREE FURNITURE PLANTS

Description	Lumber Grade: Firsts and Seconds	Number One Common	Number Two Common
Plant A			
Material Cost per net foot	$0.3106	$0.2918	$0.2498
Cut off direct labor	.0059	.0099	.0148
Rip direct labor	.0098	.0153	.0331
Total	.3263	.3170	.2977
Plant B			
Material Cost	$0.3106	$0.2918	$0.2498
Direct Labor			
Cut off	.0141	.0223	.0292
Face Planer	.0037	.0057	.0071
Single surfacer	.0037	.0057	.0071
Jointer	.0047	.0071	.0089
Rip Saw	.0098	.0153	.0331
Total	.3466	.3479	.3552
Plant C			
Material cost	$0.3106	$0.2918	$0.2498
Direct Labor			
Cut off	.0136	.0217	.0284
Face planer	.0037	.0057	.0071
Singler surfacer	.0037	.0057	.0071
Jointer	.0047	.0071	.0089
Rip saw	.0098	.0153	.0331
Total	.3461	.3473	.3344

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Width Aspects of Molders and Their Cutters

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MANY WOODWORKING PLANTS keep a rather liberal supply of cutter blanks of different widths on hand. It is possible to obtain slotted cutter blanks for the molder in widths from 1 inch upward. One cannot obtain a cutter less than 1 inch wide provided with a bolt slot, for slotting a cutter narrower than this would weaken it too much.

From the 1-inch width, however, slotted cutters in practically all greater widths desired may be obtained, the number of slots increasing as the cutters are wider, until the widest are such as will match the full lenth of the particular molder heads involved. These are generally used only as surfacing knives, but some are used as rabbeters, and sweeping curves may be ground in such knives when desired.

Molders are used in various widths in different plants. Where a 4-inch molder is referred to, it means the machine has 4-inch maximum width capacity, or heads 4-inches in length. Therefore, 4-inch knives can be mounted on the top and bottom cutterheads. As a general rule, a fair supply of wide slotted knives are kept on hand, since considerable surfacing work is to be done in many plants. Many patterns are surfaced either entirely or in part.

From the 4-inch molder, (which is usually the smallest available) the general run of molders extends all the way up to 12-inch, in increments of 2 inches. Some leading molder manufacturers also provide a 16-inch machine where desired. As a general rule, where a plant is equipped with more than one molder, one of the machines will be a 4-inch, for there is usually a considerable proportion of the work that falls within this scope.

Six-inch electric molder equipped with a hopper feed, in plant of Angelus Furniture Manufacturing Co., Los Angeles. Photo courtesy of Mattison Machine Works, Rockford, Ill.

Slotted knives are held on square molder heads with special cutterhead bolts. These bolts are designed to fit in T–slots of square cutterheads, and are generally of reinforced type. The reinforcing steel consists of a curved portion, designed to fit in the cutterhead slot without interfering with the flat face surface of the knife. It greatly reduces possibility of knife-bolt breakage. Just as a knife less than 1 inch wide cannot be slotted to receive the usual ⅝" bolt without weakening the knife too much, so a knife less than 3-inches wide cannot be provided with more than one bolt slot.

Fig. 1.—Loading small second-growth logs with shovel loader.

Fig. 2.—Four-tenth yard shovel mounted on G. I. halftrack with heel boom used to yard and load logs.

Needed: Economical New Methods of Logging Young-Growth Western Softwoods[1]

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Harvesting young-growth timber has become an important segment of logging operations in the Pacific Northwest. The change from logging of large old-growth to logging small second-growth timber has created problems unfamiliar to western loggers. In addition to size differential, there are problems of log values and timber management practices. Better logging methods and equipment must be developed.

THE PACIFIC NORTHWEST has been noted for years for its enormous volume of large, high-quality timber, but the timber scene is changing. Nearly all forests cut during the past 75 years have restocked themselves. Much of the cutover land now supports young stands of merchantable timber. In addition, young growth up to 160 years of age has occupied large areas of old burns.

In recent years, the rate of harvesting young growth has increased rapidly and these stands now supply about one-third of the 12 billion board feet of logs cut each year in the Douglas-fir region of Oregon and Washington.

Harvesting and managing young-growth timber stands have posed some new problems for loggers to solve.

1. The small young-growth timber is more expensive to log than old growth.
2. Young growth contains practically no high-quality material suitable for clear grades of lumber or face veneer for plywood and consequently commands a lower selling price.
3. For maximum long-time yield, young-growth timber should be managed by a partial-cutting method, and on the initial cuts this is more expensive than the clear-cutting practice used for old growth.
4. Partial cutting poses other problems not encountered in clear cutting.

Small timber costs more to log in all phases of the operation, but the increase is most pronounced in loading and hauling. Loading small logs at the landing, and scaling the logs at the point of delivery, increases idle truck time. The hauling rate per thousand is higher for young growth than for old growth. For example, the State of Washington recognizes a differential in truck hauling costs by allowing a rate increase based on the number of logs per load.

Cost-Cutting Methods

Loggers have tried several ways to cut costs. One way was to bundle logs in the woods to minimize skidding and loading time. Some companies built cradles to hold a number of small logs which were tied with cable or steel strapping. These bundles of logs were then skidded, loaded, and hauled as a unit. Other companies tried preloaders or separate trailers that were loaded in the woods while the truck was going to market with another load of logs. Most of these systems had serious flaws such as the added expense of duplicate equipment, inconvenience of moving the equipment, lack of landing space, and time and cost of rehandling material, and have been abandoned.

One bundling method has proved successful on gentle topography where landing space is adequate. Small logs are separated at the landing and bundled with two wire chokers which remain in place until the logs reach the mill deck. No special equipment is needed because the shovel loader used for big logs can also handle the bundles. Hauling and unloading on this operation are designed so that

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Fig. 3.—A short log truck and trailer with combined load of about 5,000 board feet.

Fig. 4.—Wyssen Skyline Crane bringing pine logs into landing.

truck loads can be made up of both big logs and bundled small logs. Bundling also has proved helpful where logs are towed in navigable waters. A large number of small logs are bundled before they are dumped into the water simply by hand-strapping two or three steel bands around a truckload of logs. Besides facilitating towing and storage, bundling also greatly reduces loss from sinkers.

One difficulty in finding economical logging methods for young growth is that skidding and loading have different power requirements. The most practical method for skidding in young growth appears to be use of small equipment and a small crew. Loading is more economical, however, where the volume handled is sufficient to justify a pneumatic-tired shovel loader equipped with air tongs. The difficulty is that this type of equipment is too expensive for a small operation. To overcome this problem of logging second-growth, a company may contract the falling, bucking, and skidding to several small operators. Such a company would then operate an efficient loader, which would move from one landing to the next, loading the trucks on a prearranged schedule. Unfortunately this system is not applicable to most operations. All in all, the cost of logging small timber will have to be lowered by developing better equipment. Fork-lift attachments for skidding tractors probably would help. Small, cheap, and fast-operating loaders are needed, or a more efficient method could be developed for handling bundled logs with present equipment.

Perhaps little can be done to change the value differential between products from young-growth and old-growth forests. Eventually all the old growth will have been harvested, but in the meantime the best possibility may be to improve the value of young timber by thinning and pruning, and by extending the rotation periods, to develop bigger and better trees. Up to 100 years of age unmanaged Douglas-fir timber will produce no clear lumber but about 75 per cent No. 1 common and structural. Young growth has one advantage over old growth in that it contains far less defect, which has a favorable effect on both logging and milling costs.

Problems of Partial Cutting

Adoption of partial cutting poses still other problems. Logging started in the Pacific Northwest at the lower elevations and on gentle topography. These areas now contain the largest young growth timber and lend themselves to partial cutting. This type of management will improve both the quality and yield of the final crop and will almost double the amount of timber that can be harvested over the rotation period. Yet little of this type of logging is being done, and that chiefly by the large companies and government agencies. The first job, therefore, is to convince the many small owners that partial cutting is good business. The second job is to develop ways and means of getting a satisfactory logging job.

Partial cutting in young growth introduces problems in selecting the trees to cut and in getting the right kind of equipment and crew so that damage to the remaining trees is held to acceptable standards. Also, much more supervision is required in partial than in clear cutting. These problems, plus the fact that partial cutting does not produce the maximum immediate returns, are probably the main reasons most of the young timber is still clearcut.

Development of equipment and crews for partial cutting has a long way to go. This region has long been noted for its large-size logging operations, using big equipment. Since the development of mobile equipment, individual operations have become smaller, and some of the large companies are encouraging small crews and horse skidding for logging young growth. Although this type of logging reduces damage to the remaining trees, it may never be used widely in the Pacific Northwest owing to the inconvenience of caring for the horses, particularly on non-operating days.

At present practically all skidding on gentle topography is done with track-laying tractors. These machines are efficient but generally cause more damage than horse skidding. The trend at present is toward pneumatic-tire tractors which cause less damage than track-laying machines but are not as efficient on wet or steep ground or on areas containing boulders and down logs. Perhaps, with additional improvements, pneumatic-tire tractors will become a suitable compromise between horses and caterpillar tractors.

Steep slopes are especially difficult. Tractors of any type work efficiently only on gentle topography, and the West has many areas too steep for tractor logging. Land managers have assumed that these areas would have to be clearcut by some cable method and they have resigned themselves to expect a smaller yield over the rotation period than in areas managed under a partial-cutting method.

Some experimental work is being done in partial cutting on steep ground. In a Forest Service test at Cascade Head Experimental Forest, a

Fig. 5.—Close-up view of carriage of Wyssen Skyline Crane.

Photo by Weyerhaeuser Timber Co

Fig. 6.—Small logs made up into bundles ready to be dumped into water for towing.

light, mobile shovel loader was used to yard and load logs from a thinning operation. This machine logged a strip about 400 feet wide, below the road, without doing much damage to residual trees. Costs were only slightly higher than for tractor logging on gentle topography. This experiment is described in Carl Berntsen's report[2] on tested methods of commercial thinning on steep ground. Additional experiments of this type are planned, but the system is applicable only to narrow strips along established roads.

Another study may develop a method for making thinnings on rough terrain as much as 1¼ miles from the road. On the Chelan National Forest in Washington, a Wyssen skyline crane, developed in Switzerland, is being tested. This machine has a one-inch cable tramway extending from the landing a mile or more uphill to a power unit. A carriage is moved along the skyline by means of a half-inch operating cable. A patented stop mechanism on the skyline holds the carriage in place while the operating line lowers the chokers. The operating line is then used to raise the logs to the carriage where they are held while being lowered by gravity to the landing. Brakes on the machine control the speed that logs travel down the skyline. Power is required only for moving the empty carriage and for raising the logs from the ground to the skyline.

Where road costs are normal, logging is more expensive with the skyline crane than with ordinary cable systems. On very steep or rocky ground, however, where road costs are high, this system should have a cost advantage. Probably the machine can be used successfully where soil disturbance must be held to a minimum, such as on areas with easily eroded soils or on municipal watersheds.

From these few examples, loggers and equipment manufacturers should see plenty of opportunity to improve logging methods in young-growth timber. More and more young-growth timber will be cut in the Douglas-fir region. Also more small lodgepole pine will be harvested in the pine region. The best of the logger's ingenuity and much more development work by manufacturers will be needed to devise economical new methods for logging western softwoods.

[2] Berntsen, Carl. June 1954. Commercial thinning on steep ground. The Timberman.

Discussion

P. L. Northcott (Forest Products Laboratories of Canada, Vancouver): What progress has been made to provide a satisfactory substitute for horses for bunching logs in second-growth timber, keeping in mind the excessive damage done to the residual stand by tractors?

Mr. Matson: Pneumatic-tired tractors have been tried on an experimental forest. They worked well on dry ground but gave some trouble on wet uneven ground. As improvements are made in this machine, it probably will prove a good substitute for horse logging. The Weyerhaeuser company and a few others are able to get horses for their thinning operations. Rubber-tired tractors, of course, do less damage than steel track jobs.

C. S. Herr (Brown Co.): We operate back in northern New Hampshire, the traditional home of horse skidding. We find it more and more dffiicult to keep horses on the job. Good teamsters and horses are difficult to find. Horse feed is scarce and high priced. Horses have to be cared for over the weekends and during idle periods. Consequently we are shifting to crawler and rubber-tired tractors.

M. H. Mater (Mater Engineering): Have you made any cost studies on helicopter logging? With the tremendous costs of access roads (up to $70,000 per mile in the West), logging roads ($5,000 per mile or more), trucks (more than $20,000 each), maintenance and labor (at more than $2.00 per hour), I think it's time for a serious study of possibilities of helicopter logging.

Mr. Matson: We haven't made any studies of use of helicopters, and I don't know of any such studies that have been done.

W. E. Fountain (Forest Products Laboratories of Canada, Vancouver): A Canadian pulp and paper company has studied some of the costs of helicopter operations in respect to logging. Information about their operation is available from the Supt., Forest Products Laboratory, Vancouver.

Mr. Simmons: The McCulloch Co. (well-known chain saw manufacturer) is presently seriously considering the potential in this field.

R. B. Daley (Daley Lbr. Co., Indianapolis): We have been logging and hauling second-growth in Mississippi for 30 years. We use "loggers dream" quite a bit and our costs run about $17 to $20 a thousand for cutting, bunching, and hauling. How does this compare with costs in the Northwest?

Mr. Matson: Costs are much higher here, probably mainly due to higher road and labor costs.

Increasing Sawmill Efficiency[1]

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Sawmill efficiency can be increased in small mills as well as large mills. Analysis, self-criticism, and acceptance of new machinery and working concepts, especially in lower capacity mills, will help cure some of the ills of the lumber producing industry. This paper summarizes efficiency factors which will enable greater lumber production at a savings in time, labor, and money.

THE PURPOSE OF THIS PAPER is to start the sawmill operator thinking about his operations and to serve as a guide in analyzing his processing of logs into lumber.

The word efficiency to the sawmill operator means the greatest return for his investment in capital, labor, and time. The efficiency of a sawmill may be measured by the level of production of lumber or allied sawed products of the quality desired by the owner compared to the input of capital, time, physical effort, and mechanical operations required to produce the material.

Probably at no time has efficiency of operation been as important as it is now, and as it appears it will be in the future. The sawmill operator is caught in the vise between the jaw representing high stumpage costs and low labor productivity, and on the other hand the nether jaw of prices for his product which are largely out of his control.

Changing Conditions

The sawmill operator in earlier years relied to a certain extent on low cost of materials to cushion his operating costs. Stumpage was generally plentiful and cheap, and often could be purchased at a price advantageous to the buyer. The rise in stumpage prices throughout the country has been phenomenal. Woodlot owners and timberland holders are better informed regarding volume and value of standing trees, and are less inclined to sell without assurance they are obtaining full value. The constant educational activities aimed at the timberland owner by public and private agencies has sometimes given him an over-inflated impression of what stumpage should bring, which has made the operators' lot no easier.

There is no foreseeable possibility of an immediate change in the labor market, except in the direction of higher wages and a lower caliber of worker for the sawmill industry. It appears that every operator, unless very fortunate in this respect, is employing some workers who a few years ago would not have been considered suitable sawmill labor. The sawmill owner or operator seems to have adopted a pessimistic attitude toward his employees: that he will accept men of lower work capabilities than will other industries, that men for the sawmill occupations need not be as intelligent, physically fit or socially acceptable as for other fields of endeavor.

With the exception of the west, the wages paid to sawmill workers are on the average lower than in other heavy industries. Part of this stems from the operators' unwillingness to pay higher wages, and partly because they cannot afford to pay them at the present rate of productivity. The higher minimum wage may force some operators to sell out, others will tighten their belts and by increasing sawmill operating efficiency will take up the extra burden and continue to produce lumber.

Of the other factors which enter in production costs, such as overhead or ownership costs, machinery, fuel, lubrication, repairs, taxes, compensation, etc., we can only assume that they will continue at the present level, or go even higher. Compared to costs of logs and labor, they represent a smaller proportion of the total cost of producing a thousand feet of lumber and, at the best, savings effected in these secondary items can hardly be expected to be more than minor in nature.

The possibility of setting the price which the sawmill operator receives for his product appears to be remote. Only competition, supply, and demand can regulate this factor, He can, however, in many instances improve his selling position by such means as developing new markets, diversifying his production, or carrying his product through another stage of manufacture.

Benefits of Increased Efficiency

Since the lumber manufacturer is faced with the prospect of continuing or increasing high costs of production and no promise of increased prices for his product, he should increase the efficiency of his mill to a point where there will be something left at the end of the day for profit and risk. The benefits to be derived from increased efficiency, of course, include not only a greater margin of profit and risk, but also an improved capital position, an ability to attract better and more stable workers, and an improved competitive position in the struggle to obtain suitable timber.

One of the factors holding back increased efficiency is the lack of information regarding actual costs of individual operations within the sawmills. Cost accounting systems vary considerably in their inclusiveness and intensity. Thousands of small operators have no conception of what it is costing to perform a particular function in the process of manufacturing lumber. Therefore, they have no basis for comparing what a change in machinery or methods will mean in the way of unit profit. Merely increasing the rate of production or the out-turn of a higher grade product, or producing a more orderly flow of material, does not necessarily increase efficiency. It is only when the rate of return per unit of production increases as a result of a change that an increase in efficiency may be claimed.

It is conceivable that for a smoothly operating manufacturing concern, part of the return will be represented by the satisfaction and pride of the owner in his establishment. A slight change in work method may not increase production but only reduce fatigue of a worker. The only return in this instance is in the field of employer employee relations, yet surely efficiency has been improved. In other words, a return measured in dollars and cents is not the only indicator of efficiency.

Before the sawmill owner decides to increase the degree of mechanization, to change layout and work methods, to conveyorize his material movement, to exchange one type of machine for another, or to make any other change, he must analyze his present operation and his product. If on the

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basis of his analysis he can prove to himself that it is sound economically, then is the time to make the change. At the same time he must decide why he wants to make the change. Is it because he wants a larger profit so that his financial situation will improve? Is it because he wants to stabilize his labor situation? Is it because analysis indicates that he is losing sales because his product is not meeting changing markets? Is his machinery obsolete or worn out so that its production rate and its quality will not meet the customers' requirements? These and many other questions could arise.

If analysis shows that the sawmill meets the owner's income wants, that the owner's and the worker's lot is a happy one, that the mill is producing well-manufactured lumber, and that the amount of waste is the least that can be produced by the particular type of mill when in good condition and carefully operated, then changes are out of order. Study, analyze, consult, calculate, and then decide to jump or stay put.

Efficiency in the sawmill may be increased in many ways. As Mater (11)[2] has indicated, mechanization is one of the keys to greater efficiency and greater profits. Mechanization alone, however, will not accomplish greater efficiency. Better training of workers in their jobs and better maintenance of equipment must accompany the mechanization. More thorough understanding of logs, their defects, and their effect on the product must be acquired. Closer tolerances of manufacture and control of operating processes must be attained. Material must be moved from one processing point to another in an orderly flow at the top of machine and human capacity. After analysis, the operator must choose the type of the machines which will perform the desired results, and he must make the decision as to how far mechanization can go before an economic break-even point is reached.

Proper Attitude

Before considering how the steps toward greater efficiency may be attained, it might be appropriate to consider one other facet of production efficiency that is often forgotten. This facet is represented by the opinion held by many regarding sawmills and their product. The concept that sawmills are not precision manufacturing machinery and that lumber in the rough is subject to so many variables that it can not be treated as other materials is a defeatist attitude. Too long these conditions have been accepted as being inherent to the sawmill and its product. Too long our lumber has been sawed oversize and shrugged off with "It will come off in the planer". Too long our machinery has taken the blame for waste and inefficiency when it is a lack of proper maintenance, lack of understanding of basic cutting techniques, and an unwillingness to accept modern manufacturing techniques.

Sawmills as devices for breaking logs down into lumber have been designed for ruggedness and for accuracy and flexibility. They are subjected to terrific shock loads, and the wear is extreme. The sawmill may not fall into the class of our conception of a precision instrument, but under competent operation it is capable of producing lumber with dimensions within fairly close upper and lower control limits and with less waste than is now being produced.

The primary difficulty in achieving a more healthy outlook on sawmill machinery apparently stems from the conception of wood as an unpredictable material. As a consequence, the operator has in many cases set a margin of safety far beyond that which is necessary. The answer to these two problems is to first learn all that can be learned about wood itself, and second to learn the natural manufacturing limits of the sawmill and keep it operating within those limits.

A paper on increasing mill efficiency would not be complete without some consideration of the logs and the possibilities of treatment of the logs prior to introducing them into the sawmill. We have read and heard a great deal about log grading, and the substantial gains to be obtained by buying on grade (10, 18). The same profits may be obtained by the sawmill man who does his own logging, by manufacturing logs to improve the grade. Many a mill manager prides himself that every machine operator in his mill is a lumber grader. Is it any less logical that every logging employee should be a log grader, and is it any more difficult to achieve this end?

The day has about passed when size is the only criterion for quality. It is becoming increasingly important that every sawmill operator take an interest in establishing fair and workable log grades. If this has already been accomplished, then these grades need more than a casual trial. The grades (18) suggested for hardwoods require less time to learn by far than the art of hardwood lumber grading. As the general level of log quality decreases, the need increases for information and training in the field of wood's characteristics and behavior, of which log grading is a part.

Debarking Aids Efficiency

One of the interesting and most encouraging phenomena regarding wood utilization has been the debarking of logs before sawing. The primary purpose in most instances was to produce bark-free slabs and edgings for conversion to fiber products. At the same time, the sawmill operators discovered that bark-free logs on the headsaw resulted in small, but profitable increases in yield and grade on the green chain, and decreased costs of saw sharpening and maintenance. The growth of this type of endeavor appears to depend partly on the development of lower priced debarking services and chipping equipment. The other factors influencing greater development of this type of log treatment are the problems of concentrating the chips and shipping to the pulp and paper mills.

The manufacturers of debarking equipment are actively engaged in development of improved machines, and it is expected that developments in the field of utilization of hardwoods for pulp and paper products will promote even more activity. Already, the volume of chips produced from slabs, edgings, and trim has reached a point where efforts are being made to standardize chip sizes to meet the pulp-mill requirements.

Even where the sawmill is not in a position to justify complete debarking of the logs, cleanliness of logs fed into the headsaw is an important item. The two problems, of course, are imbedded materials overgrown by wood and the foreign objects in the crevices and fissures of the bark acquired during skidding. The former may be detected, if metallic, by electronic detectors, although these are not entirely foolproof. When metal is struck by a saw, whether circular or band, it is costly in time and money. The delay time may amount to only a few minutes while the saw is being changed, or in some smaller mills it can mean a complete shutdown for a half hour or more while teeth are replaced and the saw checked for damage. One band mill owner informed the author that he estimated it cost him $50 every time metal was struck.

Dirt, sand, mud, gravel, and ice on the exterior of the log are more commonly encountered obstacles to continuous operations. Here the efficiency is seriously impaired and saw filing and fitting costs go up rapidly when dirty logs are sawed. Under extreme conditions, the saw may be filed after every log. A set of teeth and a sawyer's temper do not hold up long under such conditions, nor does the owner's pocketbook.

If dirty logs are delivered to the

[2] Numbers in parentheses refer to literature cited.

mill, a number of devices have proved helpful. The log pond and high pressure spray have long been common equipment in medium and large sawmills, but the smaller operators have generally been slow to install log cleaning devices. It is interesting to note, however, that many small permanent or semi-permanent mills have installed small ponds with natural earth, wood crib, or concrete walls. Although these ponds are not too effective as washers, they do loosen the accumulation of mud and grit to a certain degree, making further cleaning easier.

Where ice covered or frozen logs are encountered, a hot pond is sometimes helpful. It is still a question in the minds of some sawyers whether logs which have been frozen and partially thawed in a hot pond are better or worse than completely frozen logs. One of the advantages, of course, is that foreign matters embedded in snow and ice are melted from the surface of the log.

Another application of the washing principle is used where a supply of water is available by pumping water to the approach to the log deck. At this point a hose is used to wash the logs. At mills where sufficient steam is available, a mixing valve permits steam and water to be used, giving a more effective washing action and one that can be used in freezing weather as well as at other seasons. A proper shielding and drainage system should be installed so that there is no accumulation of water at the deck.

One adaptation of the old-time rock saw has been noticed in a number of the smaller mills, and at least two makes are on the market in the east. This is a small diameter, 8–14 inches, electrically driven wheel on which cutting teeth are mounted, the wheel suspended in a frame which can be swung into the line of cut by the sawyer so that bark on top of the log is removed ahead of the saw. These units often are home made and utilize an old cutter head for the rossing effect. They are reported to be quite effective, but they must be heavy enough so that the frame will not twist or shift, thus permitting the bark wheel to get out of line.

Analyze Operations

The fundamental question facing many sawmill operators today does not revolve around the need to replace their present equipment with similar machinery of more modern design. The real question hinges around an analysis of the entire picture of lumber production, including quality of logs, developments in the re-manufacture of wood products, changing markets, and changing public demand. It may be that an analysis of these factors will indicate the replacement of present machinery by types now either experimental or limited in number.

Photo courtesy Soderhamn Machine Manufacturing Co.

Tractor mounted Cambio barker may be used for debarking pulpwood. Machine will handle logs ranging from 2½ to 26 inches in diameter.

Both Telford (14) and Bell (6) in their studies of comparative efficiency of different types of mills have concluded that the common "portable" circular headsaw is near the bottom in efficiency from the standpoint of production and accuracy of sawing. In the latter study it is interesting to note that a twin circular headsaw plus a resaw and edger produced lumber from small logs in less man minutes than any other type of mill. Telford's study also indicates that a mill of this type with electrically actuated saw spacing produced at the highest rate of all the mills studied, with the exception of one of the log sash gang mills which was cutting a larger average log. Although these twin circular mills were cutting 2- and 3-inch stud material, their design and production is such that they will warrant further study. It is possible that mills of this type coupled with resaw equipment would offer excellent production of other types of lumber at very low cost in man hours.

Telford's study (14) includes several log sash gang mills, including two of the double gate type. Here again the indication is that production in lumber tally is high, but that costs per thousand board feet are also high because of the heavy initial cost of equipment. The pros and cons of log sash gang mills have been presented numerous times, but the conclusions generally drawn are that they require better organization to operate and that the operators must understand the machines' characteristics. No mill owner should contemplate installation of a sash gang headsaw until he has studied thoroughly the operating characteristics of the machine.

A number of sash gang mills are scattered over the Northeast and other sections of the United States, and the owners have operated them for a sufficient period to arrive at definite conclusions as to their economy. Some of them are being used both as head saws and as cant resaws, for which latter purpose this type of mill has long been used in large sawmills.

As headsaws the log sash gang will undoubtedly produce more lumber per cubic foot of log. The surfaces are fairly smooth, and thickness is uniform. They are not foolproof, however, in the latter case, because the author has observed an instance of large splinters jamming between saws, forcing one over and causing thick and thin boards. For best results, logs must be segregated by grade and size so that comparatively long runs can be made between saw setups. This contrasts sharply with the normal operation of common circular and band headsaws which can take logs as they come.

In addition to the twin circular and the log sash gang mills, combinations which utilize a splitter and resaw, circular or band headsaws and cant resaws, band headsaw and horizontal or vertical resaws, fixed multiple headsaws and others have been utilized. The objective in most instances is to reduce the time spent in loading the carriage, turning the logs, gigging back the carriage, and operating the setworks. As these items are reduced or eliminated, the time during which the saw teeth are actually in contact with wood is greatly increased.

Bell (6) reports in his study of 50 sawmills that the percentage of time during which the headsaw was in the cut varied from 30 for the circular headrig to 45 for compound band and twin circular mills and to 88 for the log gang mill. Although this is not necessarily a criterion for efficiency of production because of other factors such as feed speed, size of logs, power available, and cuts made per log, it opens up the field of critical analysis of the present types of machinery.

A report (5) of a study made in

British Columbia at a band headrig indicated that only in the setting operations could any considerable time be saved. This investigation indicates that 25 per cent of the time consumed in sawing logs was spent on setting. The pre-setting of the set works would be necessary to accomplish a savings in time, although a combination of presetting plus limit switches to eliminate the possibility of actuating the saw while in the cut was suggested to permit faster setting. The report does not look favorable on the possibility of reducing time of the other phases of headsaw operation using the present equipment.

Utility of Bolters

In recent years, the bolter headsaw, which is well known in the New England states but is not so common in other sections, has had some speculative eyes cocked at it. Here again, as with the log sash gang, a mill man accustomed to a conventional circular or band headsaw might find himself in difficulty were he to convince himself that here is the answer to his prayer for a mill requiring a modest investment and yielding higher percentages of quality material than he is obtaining from his present mill.

The bolter is a specialized type of headsaw which for many years has been producing handle stock, dimension, turning squares, and other specialty items. In the hands of an experienced operator and with proper supervision, it has a number of advantages over the long log sawmill in producing some specialty items. It is not expected that the bolter will replace conventional sawmills or that bolter products can compete with many lumber products, because of design of mill and production peculiarities. Its popularity is increasing in other sections than the Northeast, and studies are now under way both in the United States and Canada to augment the rather scanty data now available on their efficiency. It may be that these studies when completed will indicate that the bolter has utility beyond the use to which it is now being put.

Already, we have commercial operations in which the conventional mill and bolter are installed so as to complement each other. Those logs which are reasonably high in grade are sawed on the conventional mill. Those which, in the judgment of the operator, are better suited to bolting are cross cut to shorter lengths. In the process, defects such as sweep may be reduced, and defective sections of the log may be removed. It is anticipated that the bolter will be of value in utilizing low grade hardwoods which now are not marketable.

Photo courtesy Forest Products Laboratories of Canada

Flat stock production on short-log bolter—sawing a hardwood bolt parallel to the bark for higher grade recovery.

New Machinery

In addition to the possibilities offered by investigations into other arrangements of log breakdown devices, it might be well to review what is available from manufacturers of the circular and band headsaw, carriages, feeds, and attendant equipment. That sawmill machinery manufacturers build well is attested by the thousands of ancient sawmills still operating in this country. The owners and operators of these mills appear to have the same attitude toward their equipment that the fanciers of old cars had toward their ancient horseless buggies. They once were the pride of the road and accomplished their purpose in the day for which they were designed, but they cannot compete in comfort, reliability, and efficiency with the modern automobile. By the same token, a sawmill designed to produce lumber when conditions of timber supply, quality of logs, labor, and consumer demand were at great variance to our present day conditions, cannot be expected to meet the competition of a modern mill.

Many mill men seem to be unaware of the improvements available for their machinery. They are still trying to compete with a horse-and-buggy sawmill against the streamlined operators. Fortunately, the more progressive sawmill manufacturers have for a number of years incorporated into their machines modern hydraulic, pneumatic, and electronic power and control devices. Also, a few manufacturers of small sawmill equipment have developed machinery using these principles within the last few years. They are transmitting power by the most efficient means and fighting friction with well designed bearing and improved lubrication systems. They are developing feed-works that replace the old steam, belt, and friction feeds and improving performance and safety.

The modern sawmill carriage, with its electric air and hydraulic controls, bears little resemblance to that of 20 years ago. One man push-button headsaw operation is no longer a dream. Even the small mill class has been affected, although the development here is not so pronounced as it is in the larger mills. These pushbutton mills still require the skilled judgment and control of an experienced sawyer, but they come as close to "automation" as our present development in the field of sawmill equipment permits.

Much has been written and spoken of the concept of "automation". It would appear that it were a word with which we could conjure up machines which would dissolve the manufacturer's problems. Possibly on the sketch board there may be a sawmill into which the log will disappear and from which lumber and by-products will appear without the necessity of human judgment or labor. When one considers, however, that the machines capable of analyzing and automating an operation normally require years of development and large capital outlays, it sets one to considering skeptically, but not without hope, the claims for the automatic sawmill.

Professors Norbert Wiener and Donald Campbell state (17) that, "in the vast majority of cases we are not yet in possession of the mathematical theory and the information necessary to reduce the whole sequence of operations to a form suited to the use of fully automatic machinery. The business man has not yet become quantitative in his treatment of the business problems. Until he does, fully automatic plants will not be built, and automatization will be little more than increased mechanical complexity, with a few feedback techniques or servotechniques introduced as a seasoning to a very old dish".

In the same article, Professor Wiener states "It is because we believe in the general soundness of the idea of automatization, and because we are conscious that the word is being bandied around by many people, some of whom have nothing to contribute to the field and who are unaware of the most elementary ideas of the subject, that we do not wish to see these fields of engineering flare up and get a bad name which can only lead to the discrediting and the crippling of their normal development".

This should not preclude, however, the fact that machines or instruments already exist which will either perform mechanically the tasks ordinarily ac-

complished by human labor, or when preset by human hands perform actions faster and more accurately than physical bodily action. An example of the former might be the simple process of moving lumber to its proper concentration point. At the key point the human brain makes the decision as to what grade a board is. Then by an automatic sorter the lumber travels over rollers between walls and drops into the proper bin, when gravity trips the board on the basis of length. An example of the latter is the pre-setting device for sawmill carriage setworks which carries out the sawyer's wishes more rapidly and more accurately than the best team of sawyer and setter. The fact still remains, however, that instrumentation to measure and machinery to control are not developed overnight.

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It is well known that if this production time is devoted to breaking down cants, the board footage at the headsaw will be greater than when cutting boards and dimension. If the resaw installation is balanced with the headsaw so that it can take the volume of flitches and cants produced by the headsaw, then sawing time per thousand board feet can be reduced.

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British Columbia at a band headrig indicated that only in the setting operations could any considerable time be saved. This investigation indicates that 25 per cent of the time consumed in sawing logs was spent on setting. The pre-setting of the set works would be necessary to accomplish a savings in time, although a combination of presetting plus limit switches to eliminate the possibility of actuating the saw while in the cut was suggested to permit faster setting. The report does not look favorable on the possibility of reducing time of the other phases of headsaw operation using the present equipment.

Utility of Bolters

In recent years, the bolter headsaw, which is well known in the New England states but is not so common in other sections, has had some speculative eyes cocked at it. Here again, as with the log sash gang, a mill man accustomed to a conventional circular or band headsaw might find himself in difficulty were he to convince himself that here is the answer to his prayer for a mill requiring a modest investment and yielding higher percentages of quality material than he is obtaining from his present mill.

The bolter is a specialized type of headsaw which for many years has been producing handle stock, dimension, turning squares, and other specialty items. In the hands of an experienced operator and with proper supervision, it has a number of advantages over the long log sawmill in producing some specialty items. It is not expected that the bolter will replace conventional sawmills or that bolter products can compete with many lumber products, because of design of mill and production peculiarities. Its popularity is increasing in other sections than the Northeast, and studies are now under way both in the United States and Canada to augment the rather scanty data now available on their efficiency. It may be that these studies when completed will indicate that the bolter has utility beyond the use to which it is now being put.

Already, we have commercial operations in which the conventional mill and bolter are installed so as to complement each other. Those logs which are reasonably high in grade are sawed on the conventional mill. Those which, in the judgment of the operator, are better suited to bolting are cross cut to shorter lengths. In the process, defects such as sweep may be reduced, and defective sections of the log may be removed. It is anticipated that the bolter will be of value in utilizing low grade hardwoods which now are not marketable.

Photo courtesy Forest Products Laboratories of Canada

Flat stock production on short-log bolter—sawing a hardwood bolt parallel to the bark for higher grade recovery.

New Machinery

In addition to the possibilities offered by investigations into other arrangements of log breakdown devices, it might be well to review what is available from manufacturers of the circular and band headsaw, carriages, feeds, and attendant equipment. That sawmill machinery manufacturers build well is attested by the thousands of ancient sawmills still operating in this country. The owners and operators of these mills appear to have the same attitude toward their equipment that the fanciers of old cars had toward their ancient horseless buggies. They once were the pride of the road and accomplished their purpose in the day for which they were designed, but they cannot compete in comfort, reliability, and efficiency with the modern automobile. By the same token, a sawmill designed to produce lumber when conditions of timber supply, quality of logs, labor, and consumer demand were at great variance to our present day conditions, cannot be expected to meet the competition of a modern mill.

Many mill men seem to be unaware of the improvements available for their machinery. They are still trying to compete with a horse-and-buggy sawmill against the streamlined operators. Fortunately, the more progressive sawmill manufacturers have for a number of years incorporated into their machines modern hydraulic, pneumatic, and electronic power and control devices. Also, a few manufacturers of small sawmill equipment have developed machinery using these principles within the last few years. They are transmitting power by the most efficient means and fighting friction with well designed bearing and improved lubrication systems. They are developing feed-works that replace the old steam, belt, and friction feeds and improving performance and safety.

The modern sawmill carriage, with its electric air and hydraulic controls, bears little resemblance to that of 20 years ago. One man push-button headsaw operation is no longer a dream. Even the small mill class has been affected, although the development here is not so pronounced as it is in the larger mills. These pushbutton mills still require the skilled judgment and control of an experienced sawyer, but they come as close to "automation" as our present development in the field of sawmill equipment permits.

Much has been written and spoken of the concept of "automation". It would appear that it were a word with which we could conjure up machines which would dissolve the manufacturer's problems. Possibly on the sketch board there may be a sawmill into which the log will disappear and from which lumber and by-products will appear without the necessity of human judgment or labor. When one considers, however, that the machines capable of analyzing and automating an operation normally require years of development and large capital outlays, it sets one to considering skeptically, but not without hope, the claims for the automatic sawmill.

Professors Norbert Wiener and Donald Campbell state (17) that, "in the vast majority of cases we are not yet in possession of the mathematical theory and the information necessary to reduce the whole sequence of operations to a form suited to the use of fully automatic machinery. The business man has not yet become quantitative in his treatment of the business problems. Until he does, fully automatic plants will not be built, and automatization will be little more than increased mechanical complexity, with a few feedback techniques or servotechniques introduced as a seasoning to a very old dish".

In the same article, Professor Wiener states "It is because we believe in the general soundness of the idea of automatization, and because we are conscious that the word is being bandied around by many people, some of whom have nothing to contribute to the field and who are unaware of the most elementary ideas of the subject, that we do not wish to see these fields of engineering flare up and get a bad name which can only lead to the discrediting and the crippling of their normal development".

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complished by human labor, or when preset by human hands perform actions faster and more accurately than physical bodily action. An example of the former might be the simple process of moving lumber to its proper concentration point. At the key point the human brain makes the decision as to what grade a board is. Then by an automatic sorter the lumber travels over rollers between walls and drops into the proper bin, when gravity trips the board on the basis of length. An example of the latter is the pre-setting device for sawmill carriage setworks which carries out the sawyer's wishes more rapidly and more accurately than the best team of sawyer and setter. The fact still remains, however, that instrumentation to measure and machinery to control are not developed overnight.

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Cutting Tool Research

The manufacturers of saw blades, whether circular, sash gang, or band, should be commended for their research and development in the field of metallurgy and saw design. That these manufacturers are constantly searching for better saws is attested by their interest in developing new types of cutting tools which will take higher feeds, will remain sharp longer, and will require less maintenance under adverse operating conditions. Research is continuing in this country and Canada, and abroad a like activity is taking place with very interesting results in England and the Scandinavian countries. Just where we stand today on tooth design is difficult to say, but it can be said that a great deal of basic research is being carried on, from which we may eventually expect results that will speed up sawing and improve the surfaces of the sawn materials.

One of the charges made against the sawmill operator is that he runs a piece of machinery until it breaks. As Waldo (16) has pointed out, "production requires consideration of machines". Worn machines result in slow and faulty production and costly breakdowns. These in turn lead to delivery delays, re-operation, and excessive repair time. Wear in machines is a normal process, and in sawmilling machines it is aggravated by heavy loads and adverse operating conditions. However, it can be reduced to a minimum by the proper maintenance, which includes analyzing the equipment and process to determine the reasons for excessive wear, setting up a program of preventive maintenance, and carrying it through.

The band mill has achieved its reputation for producing better manufactured lumber not because it is inherently a more accurate sawing device, but because where bandmills are installed the maintenance program is usually well organized, well supervised, and well manned. Worn band mills are just as capable of producing miscut lumber at lower efficiency rates as are worn circulars. The fact, of course, is that heavier construction of the band mill plus regular inspection of mill equipment, lubrication, adjustment, and replacement of worn parts will result in higher production rates, longer periods between machine replacement, unbroken production and higher quality products. This holds true regardless of the size of the sawmill or the type.

Each operator, no matter what kind of equipment he is operating, should have a regular routine of inspection of his sawmill equipment. Some points will require hourly or daily inspection. Other points may require periodic inspection at longer intervals, but a mental or written check sheet should be at the operator's command to assist his "fix it before it breaks" policy.

Quality Control Is Essential

Quality control in the sawmill may vary from practically none at all to extensive systems of inspection and control. Grantham (9) emphasizes that generalizations regarding quality control in the sawmill industry are out of order, inasmuch as no two mills have the same quality of logs, manufacturing equipment, level of skill of labor, and markets.

The subject of quality control as practiced in individual sawmills has been reported in a limited number of articles. When discussions of quality control at the sawmill arise, the opinion is always expressed that sawing for grade is more important than thickness or width of the lumber. Admittedly, sawing for grade and installing operating policies which will increase the output of a greater percentage of the higher grades is one means by which the sawmill man can insure continued profitable operations. The argument, actually, is inconsequential, isasmuch as thickness and width control will contribute to increased volume of recovery of the higher grades of lumber. These two, plus attention to grading of logs and sawing for the products for which the logs are suited, have been the objects of much study in recent years, but dimensional quality control in the sawmill has been the least investigated.

The work Bethel, Barefoot, and Stecher (7) performed in setting up quality control by statistical analysis and further work by Bethel (8) indicate there is a real advantage to be obtained by dimensional control. Although their work was performed in connection with small circular sawmills, there is no indication that statistical quality control cannot be applied to the larger mills. In fact, the larger mills are in a much better position to carry out this type of program than the small operators.

Once set up, even for a small mill, a periodic check of the quality factors will indicate whether or not a mill is operating within the limits of which it is capable. If it were more generally applied, we would have dimensions which were on the average closer to the nominal size, and a narrower pattern of variation. In addition, there would be fewer rejects and better maintenance of mill facilities, because analysis of the control charts will indicate the causes for miscuts and they can be corrected almost immediately.

Some quality control programs consist of nothing more than producing lumber that is extra thick, extra wide, and extra long to insure that scant dimensions will not cause rejection or degrade. This means excessive volume in each board because of the wide range of variations caused by a poorly adjusted and maintained mill and by operation of machines by inadequately trained and supervised workers. In other lumber processing establishments, quality control is a function of the workmen, each individual being held responsible for quality of the material within his control. At some mills department foremen periodically check the quality.

In allied wood using industries, inspection may be the function of a separate department, and checks are run at regular intervals. Means for inspection may vary from visual examination to use of rules, go-no-go gauges, special lumber dimension gauges, and micrometer and dial gauges.

The use of a simple gauge indicating over or under size, once the maximum and minimum values have been established, will sometimes produce excellent results. The tolerance for excess dimensions over the dressed sizes to allow for shrinking, warping and dressing will vary from species to species. Only a thorough understanding of wood based on study will provide an answer to the question of how much tolerance is necessary. When this is combined with a knowledge of machine capability, worker's skills, and organization of an inspection plan, a real contribution to operating efficiency will be made.

Plant Layout and Material Handling

Of all the phases of sawmill operation, probably more originality has been demonstrated in layout and movement of materials than in any other part of mill design. At least, there is more diversity of opinion and less conformance to standard than is found in other phases. As Saunders (12) pointed out, there are at least four requirements which should be met in planning a sawmill layout: mechanization, versatility, comfort, and waste disposal. Other factors which will enter into the picture will be type of product developed, equipment available, and type of power.

A general axiom might be projected regarding mill layout and movement of material: select the points at which decisions must be made and make every effort to eliminate manual handling between these points. The sawmill operator who takes advantage of the forces exerted by gravity, by feed rolls and belts, and by chain and

cable conveyors, is the operator who is most likely to show a profit on his books at the end of the year. If a workman can make a decision, carry out the selective action, initiate the impulse, and forget the subsequent disposal of the board, he will be able to make a greater number of decisions during the day and to make more carefully considered decisions.

For the sawmill, movement from the log deck through the mill and to the seasoning yard is possible without human hand being laid on the lumber. Although this concept is confined largely to sawmills in the high production class, it is conceivable that human ingenuity will develop greater use of conveyorized equipment in the smaller mills to approach this objective. Already, we see even portable mills rigging a flat belt over the headsaw offbearing rolls so that slabs are sped on their way to the burner or cut-off saw, and lumber to the trimmer and green chain. Several types of automatic slab saws are on the market for the small and medium mills which do not have a slasher and although their design sometimes requires that they be reworked by the user, they are definitely a step toward that goal of automatic job performance.

More mills are using powered rolls, jump conveyors, screw roll conveyors, and the innumerable types of chain conveyors to move material. True, these conveyors require more planning to perform smoothly, but they achieve the objective of moving materials to a designated point without need for human intervention. A source of electric power is not necessary for successful conveyor operation. Many a conveyorized mill is using shafts and belting for transmitting power to the conveyors from the main source. Others are adapting one of the many small, inexpensive gasoline motors to perform this work. Diesel or gas motor-generator sets, while high in original cost can be used and permit flexilbility of operation. Small speed controllers may be installed, which will give flexibility, or if too expensive, it is a simple job to change belt pulley sizes when higher or lower speeds are required for comparatively long periods.

The flow of material should be planned so that it does not concentrate at one point while transfer devices are remaining idle. Distances of travel should be as short as possible to save conveyor equipment and overall plant space.

Personnel Training

One of the most important factors in increasing sawmill efficiency is the training of the workers to produce high quality lumber as rapidly as possible considering the equipment and raw material with which they have to work. No machine with which we work requires as careful selection, breaking in, or care as do the human individuals who are, in the long run, responsibile for the success or failure of the operation. Whereas a machine is expected to produce on the same basis day in and day out as long as it is adjusted and lubricated and furnished raw material and power, the worker may operate at peak effectiveness one day and at a low level the next. He is expected to work with a material, wood, which is in itself variable in its nature, to make hundreds of decisions during his work period, to push the right button, to shift the proper lever, to swing a cant hook, to lift and position a board, to load and unload, and do it quickly, without lost motion, and safely.

Photo courtesy Moore Dry Kiln Co.

Fork truck picking up stickered package which was automatically discharged from stacker onto rails seen in foreground. Trucks and bunks are bolted together and never leave rails.

In the average sawmill, the apprentice system is the means by which most workers are indoctrinated into their new work. With the exception of the organizations with well developed personnel training programs, the placing of workers on jobs is left pretty well up to the foreman who has a multitude of duties which hinder his training of new workers in the proper, most effective, and safe way of performing their jobs. If the new employee is placed with an old hand, many times the new man is frustrated by the reluctance of the old timer to impart any information. This attitude stems many times from the experienced man's attitude that "nobody told me anything, why should I give this man the information I learned the hard way". Fear of replacement by the new man is often a motive for unwillingness to teach. The extreme in the sawmill industry is the aura of mystery surrounding the sawfiler's art. Some sawfilers refuse to teach new men, others are unable to teach their trade, and as a consequence, good sawfilers are scarce.

The sawmill operator who wishes to maintain efficiency at its peak must not only be a good business man, know machinery, equipment, methods, and lumber, but he must foremost be a personnel director. If he cannot handle all these positions, then he must employ specialists, or train his foremen in the human side of his job.

Training of workers in a hurry was one of the tremendous jobs taken over by industry during World War II and out of it grew the simplified training methods of tell, show, test, and check. Every opportunity should be taken to have the workers understand the how of their job, and the why of it. Every man should know at least two jobs, and whenever possible swing workers should be available. When workers have been trained, and it costs plenty to train them, it is wise economy to see that their employment is kept as stable as possible and their income as near to competing industries as circumstances will permit. Good lighting, clean working conditions, and consideration for the worker's comfort and safety will more than pay for themselves in output by the workers.

Conclusions

Sawmill efficiency can be increased in existing mills and in planning for new mills. This holds true for the large mills as well as for the small mill, but the concentration of effort toward this end needs to be applied at the lower capacity sawmills. If we are to cure some of the ills of the lumber production industry, we can make a beginning in the sawmill itself by analysis, self criticism, and acceptance of new machinery and concepts of working. If every mill man analyzed his operation on the basis of

the following points, there would be greater production of lumber from the same number or fewer logs, at a savings in time, labor, and money.

1. Are the logs being sawed of such a quality that there is a reasonable chance of profitable conversion?

2. Is the design of the sawmill such that it will produce the maximum amount of lumber of the quality desired?

3. Is the mill maintained properly so that break-downs are at a minimum and size limitation of the lumber maintained as a regular occurrence?

4. Is the mill obsolete and should it be replaced by a new mill of the same type, or by an entirely different type of mill?

5. Is the layout of the sawmill and the movement of material such that all lumber, slabs, edgings, sawdust, and trimmings flow smoothly from point of development to point of ultimate disposal?

6. Is the operator taking full advantage of the service offered by manufacturers of sawmill equipment and of the research conducted by governmental and private organizations?

7. Is control of quality aimed not only at grades, but also at dimensions of the product?

8. Is present efficiency such that additional or others types of equipment, changes in methods or procedures, or revising mill layout, will increase the rate of return?

9. Are workers trained to perform their duties effectively and safely, and is every effort made to keep a trained working force available?

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Discussion

Q.: What organizations are now engaged in activities to assist the sawmill operator to increase efficiency?

Mr. Compton: There are numerous federal, state, and private organizations cooperating in the effort to improve sawmill operation. Among the federal agencies are the Forest Products Laboratory which has issued the "Small Sawmill Operators Handbook" and "Small Sawmills—A Pocket Guide", and cooperates in conducting short courses all over the United States. The Tennessee Valley Authority and the Forest Service Experiment Stations have conducted considerable research in sawmill economics and mechanics, and publish bulletins which are of great value to the mill operator, cooperate with other agencies in training schools and maintain experts on sawmill operation to consult with sawmill owners.

The state governments through their extension foresters and their forestry college activities have contributed a great deal to the improvement of sawmill efficiency. In some states the state agricultural experiment station and the county agents have been instrumental in promoting better sawmill practices through their educational programs.

Such agencies as the Forest Products Research Society and the American Society of Mechanical Engineers have contributed by technical studies and publications. The manufacturers of equipment have been very active in assisting the sawmill operators to solve their problems and to improve their product. Numerous other organizations, including the lumber manufacturing associations, help by holding clinics dealing with the problems of the sawmill operator.

Q.: What will a small mill with 15,000 to 20,000 board feet daily capacity cost with air actuated stop and loader, air dogs, hydraulic carriage feed and log turner, and electric setworks?

Mr. Compton: The cost of a small sawmill complete with air, hydraulic, and electric controls will vary considerably, depending of course, on the size of the mill and the completeness of the equipment. Probably a minimum for equipment and installation for a mill of this type would be somewhere around $18,000. Costs would continue on up from this point to the category of small medium sized mills, which would cost from $30,000 to $40,000.

Q.: What steps would you take first to increase sawmill efficiency?

Mr. Compton: The most important step to increase sawmill efficiency is to take time out for a few days from trying to sell every stick of lumber that is being produced by the mill and use this time to analyze the operation from the log unloading, through each step in the mill to the final delivery point. It is important that every movement of material is integrated with other movement, none interfering. The workmen should be working at a steady pace, not be held up by lack of materials or inefficient equipment. Machines should have sufficient power to meet normal operating conditions as well as the occasional overload. Probably one of the better sources of information is the men who are actually doing the work. When the information is compiled, the calculations can be made regarding the change-overs that will be necessary to bring the mill to a better level of perfection. These changes need not necessarily be made at one time.

Q.: Which of the factors that will increase efficiency is the most important?

Mr. Compton: It is almost impossible to say which of the factors that enter into sawmill efficiency is the most important. There must be a balance of machinery, labor, and capital, and in many instances a simple change in plant layout may improve the efficiency immensely. Generally speaking, it probably would be safe to say that mill layout and movement of material is probably the most important factor at the present time, although the manufacturers of sawmill equipment are now producing some

important technical changes in their machinery.

Q.: What can be done to improve sawmill safety and at the same time to increase efficiency.

Mr. Compton: Sawmill safety and efficiency run almost hand in hand. Acts which are taken to improve the operating efficiency will generally result in a safer operation. Such things as improving the layout so that things move freely and uncluttered, provision for removal of all debris, improving the lighting, improving the personnel relationship and thereby improving worker morale, providing guides and safety clothing, and reducing handling which results in so many injuries to hands and feet will all contribute to the general efficiency of the mill at the same time that they are contributing to the safety of the worker.

Bird-Dogging Overlooked Forest Materials[1]

J. KENNETH PEARCE

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Promoting, correlating, and conducting research in fuller utilization of timber grown in the State of Washington is the function of the Washington Institute of Forest Products. The Institute conducts applied research intended to correct a specific situation or aid a particular segment of the state's forest products industry. Publications are described and plans listed for future research activities.

THE INSTITUTE OF FOREST PRODUCTS was created by the Washington State Legislature in 1947 for the specific purpose of promoting, correlating, and conducting research in more complete utilization of timber grown within the state. It operates within the Department of Conservation and Development, and has its working headquarters at the College of Forestry, University of Washington.

The first major project undertaken by the Institute was a complete inventory of leftover materials on Washington logged-off lands, and in forest products manufacturing plants. This was an essential prerequisite to formulating plans for utilizing the state's unused wood resources.

This inventory, conducted throughout the state during 1949 and 1950, revealed that in Washington there existed a total of 210 million cubic feet of unused forest wood. Logging residuals totaled 113 million, of which 49 million cubic feet was of sawlog size and 64 million cubic feet was of cordwood size to a minimum of 4 inches diameter. The physical accessibility of this material is indicated by the fact that 78 per cent of it was located within 500 feet, and 49 per cent within 250 feet of logging truck roads.

Manufacturing residuals produced by sawmills, planing mills, and box factories totaled 46.2 million cubic feet. This does not include 34.6 million cubic feet of manufacturing residuals which were utilized, 180.8 million cubic feet sold as by-products (mainly fuel), and 169.6 million cubic feet used as mill fuel to produce power.

Detailed inventory data by counties and by geographic districts have been published by the Institute of Forest Products. Logging residuals are given by nine different size and quality classifications. Since the inventory was made, however, the installation of pulp chipping plants has materially reduced the volume of unused manufacturing residuals throughout the state.

Untapped Resources

In addition to unused wood available from current logging operations, a huge volume of untapped wood resources is found in the stands of minor timber types in eastern Washington which have previously been uneconomic to develop. These include true firs, lodgepole pine, mountain hemlock, and Engelmann spruce. Situated generally at higher elevations, they await construction of access roads as well as development of markets. Thinning from managed second growth forests are another potential source of wood fiber which offers a promising field to Washington's 15 pulp mills.

Following the Institute's state-wide inventory of forest leftovers by major districts, more localized inventories are in progress or in the planning stage. Institute personnel recently made an accurate mill-by-mill survey of all unutilized wood products in one western Washington county. A large wood-pulp producer expects to locate at least one debarking and chipping unit on the basis of information compiled from these survey figures.

Circular No. 5 of the Institute's "New Wood-Use Series" was published to describe a utilization plan for wood leftovers, as originated by Spokane industries through their Research Corporation and Lumber By-Products Company. Similar publicity is given to methods and equipment which have proven to be particularly efficient in handling forest products. Circular No. 1 described the Omak operations of Biles–Coleman Lumber Company as an outstanding example of good forest utilization. Circular No. 4 described improved methods of logging lodgepole pine by the same company.

Other circulars of the New Wood-Use Series gave detailed descriptions of efficient slab-collecting systems at sawmills, new pulpwood cutting and loading methods, re-logging in connection with portable sawmills, and improved methods of short-length logging.

When the Institute discovers meritorious new ideas or equipment designed to salvage unused forest products, every effort is made to find salvage material for the operators and to publicize their methods. A case in point is that of Lester Lamphiear, who invented an efficient portable unit to produce clear, vertical grain slicercants from leftover short logs on old logging shows. His equipment and methods are described in Circular No. 28, and the Institute has been instrumental in locating him with access to salvage material furnished by St. Paul & Tacoma Lumber Company, Tacoma, Wash. He has previously been successful in converting old standing fire-killed snags into cants which were sold to plywood plants for panel-facing stock.

The Institute has studied and encouraged packaging of logs and other forest products with steel strapping,

[1] Presented at meeting of the Inland Empire Section, FPRS, Jan. 20–21, 1955, in Yakima, Wash.

The Author: J. Kenneth Pearce holds B. S. F. from U. of Washington, was employed by Government of India in modernization of lumbering industry from 1923–33. He joined the U. of Washington College of Forestry as associate professor of logging engineering in 1934, was promoted to professor in 1943. Pearce has been consultant to the Institute of Forest Products since 1948, served as acting technical director in 1952–53.

Fig. 1.—Institute crew conducting a sawmill yield study of red alder. From right to left are: D. P. Thomas, U. of Washington; A. C. Wollin, U. S. Forest Products Lab; G. Stenzel, U. of Washington; G. D. Marckworth, Dean of Washington College of Forestry and Institute Director; and three student assistants from the college.

Fig. 2.—Forest inventory is conducted by Institute field crew. Checking map at right are Prof. J. K. Pearce, U. of Washington; and Prof. Andrew Holland, Everett Junior College. At left is student assistant from Washington forestry college.

in order to salvage unused wood or to economize on transportation and storage. Circular No. 6 describes log strapping, and a future Circular will publicize the results of banding old-growth western red cedar to minimize breakage in felling.

Institute "bird dogs" have been turned loose on Washington logging operations to sniff out timber losses and to point out methods of felling and bucking which will produce higher log volumes. Thus Bulletin No. 14 and Circular No. 23 have proven to be valuable textbooks for loggers.

These studies of woods operations, as in most of the Institute work, tend to be of greater assistance to small operators or individuals than to large corporate concerns whose size justifies the employment of expert supervisory staffs and trained foresters.

Circular No. 8, "Tips for Horse Loggers", might seem to indicate that the Institute staff is several decades behind in the march of progress. Quite the opposite is true, however, as an increasing proportion of logging in the Northwest is in small timber which has succeeded the original stand, and for which horses and small tractors are the most economical equipment. In managed forests, horses are found to create much less damage to the original stand than is incurred in mechanized operations.

Chemical Debarking

Several Institute work projects which are on a continuing basis include lumber yield studies of small band-saw mills, investigation of portable and semi-portable debarking and chipping units, and experiments on chemical debarking of live standing timber which is destined for pulpwood. In the latter study, the Institute plans to experiment with chemical debarking of native red alder (*Alnus rubra*).

A study of log truck weights published as Circular No. 27 titled "Better Payloads with Log Truck Bunk Scales" demonstrated to the logging industry the effectiveness of such devices in obtaining higher average payloads as well as avoiding overload fines. Corrective practices in the use of the scales was also indicated.

In the field of forest management, the Institute has made studies of partial cuttings in young-growth stands (Circular No. 22), and of forest thinnings with small tractors (Circular No. 17).

Following new mechanical developments in handling forest products, we have studied and described a system of knot-plugging to upgrade lumber (Circular No. 16) and a fast and economical new log-loading device (Circular No. 11).

Circular No. 21 advises loggers how they may market cull logs which are of too low a grade for sawmill use. Circular No. 18 describes, with numerous photographic illustrations, the type of low-grade peeler logs which may be taken from the woods and marketed as No. 3 peelers.

Marketing Assistance

The Institute's most popular publication, of which many hundreds are mailed each month to Washington citizens, is Bulletin No. 15, "Marketing Woodlot Products in the State of Washington". Designed as an instruction book for woodlot owners, this buletin covers marketing specifications and methods on northwest woodlot products from sawlogs to sword fern, and from car stakes to cascara. Bulletin No. 15 is a revision of Bulletin No. 1, originally published in 1950. It is available in quantity to schools, libraries, granges, and to any group of citizens or to individuals.

Three Institute publications which deal entirely with Washington State forest products statistics are used extensively as authoritative information for legislation, law cases, publications, and other serious purposes. Of these, Circular No. 7 combines reliable information on pulpwood and pulping; Circular No. 14 quotes figures on logging slash variables in the State; Circular No. 26 gives general statistical information on lumber and on forest products in the State, and on their manufacture.

The most recent Institute activity is the investigation and inventory of Washington State's native hardwood potential. These species have been almost completely by-passed by lumbermen, but with the present strong competition for softwood timber, hardwoods are assuming commercial importance.

A volume of well over 4 billion board feet of standing commercial hardwood species in western Washington is estimated by the U. S. Forest Service, with red alder predominating. Other important species are black cottonwood (*Populus trichocarpa*), bigleaf maple (*Acer macrophyllum*), Oregon ash (*Fraxinus oregona*) and western birch (*Betula occidentalis*).

Red alder has recently come into extensive use by a few of Washington's pulp mills, with indications that it will be used on a much larger scale in the future. Its rapidity of growth—35 or 40 years to maturity—and its habit of vigorously invading denuded areas, present an interesting new field of work in forest management.

It's obvious that none of these work projects involve basic research. In each case the research is applied, and is intended to correct a definite situation or to assist a specific sector of Washington State's forest product industry.

As with all state agencies which

rely on biennial legislative appropriations, the Institute must submit its record of accomplishment to legislative committees once every two years, with a request for a new appropriation. Committee members usually are seeking ways and means to economize, rather than to spend state funds. Therefore we must furnish a two-year record of specific cases in which we have helped to create new forest wealth or additional forest payrolls, or have assisted forest products operators in preventing accidents in the woods or mills. Thus with a limited appropriation, all work must be concentrated on research projects which are immediately applicable to industry.

Routine work at Institute headquarters is enlivened by daily inquiries received over the telephone, or by mail or personal calls from citizens who want formulas for eradicating insects from basements, closets, woodwork, or furniture, or who want to know where they can sell Cascara bark or ferns.

A hurry-call to a local lumber yard with collapsing floors uncovers an advanced case of termite attack. Another emergency trip finds an elderly woman in trouble with contractors who are installing a cedar fence of questionable grade. A logger who is removing madrona trees from a local golf course wants the Institute to find a market for the logs.

When a daily newspaper which offers cash prizes for solving crossword puzzles inserts words which deal with trees, lumber, or other forest products, the Institute's telephone is swamped with questions.

Types of Inquiries

Most of the several thousand inquiries received each year are quite serious, however. Recent calls from a towboat company concerned the specific gravity of logs of various species for long-distance towing. A barge-builder inquired about the relative durability of several native woods when exposed to superheated liquids. Hundreds of letters are received each month from school children, asking for information on forest resources and forest history.

Shake-mill operators ask where they can find salvage cedar. Hardwood sawmill operators want to locate timber, and ask about markets for alder and maple logs. Home builders inquire about proper preservative treatments for wooden sills or roofs. A woodsman requests information on the value of vine maple as a pulping wood. A museum asks for help in counting tree rings on a huge fir log section to establish historical dates.

Fig. 3.—Scaling logs from a pre-logging operation is G. D. Marckworth, Institute Director (right center), and tallying scale is W. Eastman, Jr., consulting forester. Looking on are R. N. McCullough, U. S. Forest Service, and Garfield Olson, Manager, White River Branch, Weyerhaeuser Timber Co.

Recent work projects which have not been published include a forest products industry survey of Lewis County, Washington. This was undertaken by the Institute at the request of Governor Langlie, and had as its basic purpose the creation of additional forest industries and payrolls in the county.

Several uncompleted projects include an exceedingly vital study of safety in Washington State sawmills and logging operations, a 1955 inventory of hardwood timber in Snohomish county, and a study of pulpwood volumes which are obtainable from managed young-growth forest stands.

Future Studies

Projects planned by the Institute for the coming year include a utilization and promotional study on native hardwoods; a sawmill yield study on eastern Washington commercial forest species, other than ponderosa pine, in cooperation with other public agencies; and a continuation of a 1955-season investigation of hemlock mortality from undetermined causes.

Technical Director of the Institute is Gordon D. Marckworth, Dean of the College of Forestry, University of Washington, who serves the Institute without salary. General administrative functions and preparation of publications are handled by Dr. Donald H. Clark, Assistant Technical Director. A forestry graduate of the University of Washington, he has had forest management experience in the U. S. Forest Service, U. S. Indian Service and with private interests. His logging and sawmilling experience has been in southern Oregon and in Washington. He has functioned as Secretary–Manager of the Shingle Association, has operated as an independent lumber buyer, and has been a consultant in forest products. The only other full-time salaried employee of the Institute is the efficient Secretary–Stenographer, Mary Jane Gross.

Several faculty members of the College of Forestry, all of whom have practical experience in their specialties, act as technical consultants, and often supervise summer field projects. Other field workers are recruited, as needed, from upperclass forestry students at the University of Washington.

The Institute's activities are prescribed and regulated by a nine-man Forest Products Commission appointed by the Governor, which includes well informed men in all branches of forest utilization and management.

There is no present indication that, within the next few years at least, the Institute may be in a position to conduct extensive laboratory studies or to initiate basic research projects. We do expect, however, to continue vigorously on our present plans, and to add any worthy projects which our limited facilities permit.

Vapor Drying of Western Woods[1]

W. R. CANTRELL

Technical Sales Representative, TaCo Corp., Spartanburg, S. C.

The vapor drying process can be used successfully to prepare wood for preservative treatment or condition wood after preservative treatment. Many difficulties are not readily overcome when using the process to dry general purpose lumber. These difficulties and possible remedies are discussed in the paper, which presents data obtained in drying 11 species of western woods. Equipment and operating cost estimates are given.

THE INITIAL AND PRINCIPAL USE of the Vapor-Drying Process was for conditioning or seasoning crossties and utility poles prior to preservative treatment in a pressure vessel. Various papers (1)(2)(3)(4)(5)(6)[2] have been presented, which discuss the results obtained with the process when used for this purpose. In Taylor-Colquitt's research laboratory and pilot plant at Spartanburg, S. C., much experimental work has been conducted on woods native to the southeast (7). Until 1950, however, little work had been attempted with woods of the northwest.

Through a cooperative program with the Oregon Forest Products Laboratory, in the past four years Taylor–Colquitt Co. has conducted a series of tests at Corvallis, Oregon, to evaluate the Vapor-Drying Process when used on western wood species. Also included in this paper are some data obtained by Lansell in his vapor drying work at the O.F.P.L.

Equipment and Operating Procedures

In recent years, changes have been made in vapor drying equipment which have caused a material reduction in the cost of equipment and have resulted in simpler operation. Figure 1 shows the modified vapor drying plant.

After the cylinder has been charged and the door bolted, drying agent is pumped into the bottom of the cylinder until it has reached track level. Steam is introduced into coils in the bottom of the cylinder, causing the drying agent to boil. Drying-agent vapors rise, contact the wood and heat it, thereby vaporizing water from the green wood. That portion of the drying agent vapors that doesn't condense, plus the vaporized water, passes out of the cylinder and into a surface condenser. The mixture of liquid drying agent and water then passes into a gravity separator where the water is metered and piped to waste, and the drying agent is returned to the bottom of the cylinder to be re-used.

This heating-in-vapor cycle is continued until the predetermined amount of water has been removed. After the drying agent has been pumped back to storage, a one- to two-hour vacuum (25 in. of mercury or more) cycle is employed in order to recover drying agent absorbed by the wood during the heating-in-vapor cycle.

Drying conditions are usually varied by changing system pressure or the drying agent. Also, because some woods have a tendency to absorb and hold more drying agent than others, an alternating cycle (1 hour heat, 1 hour vacuum, etc.) is sometimes used to minimize drying agent loss.

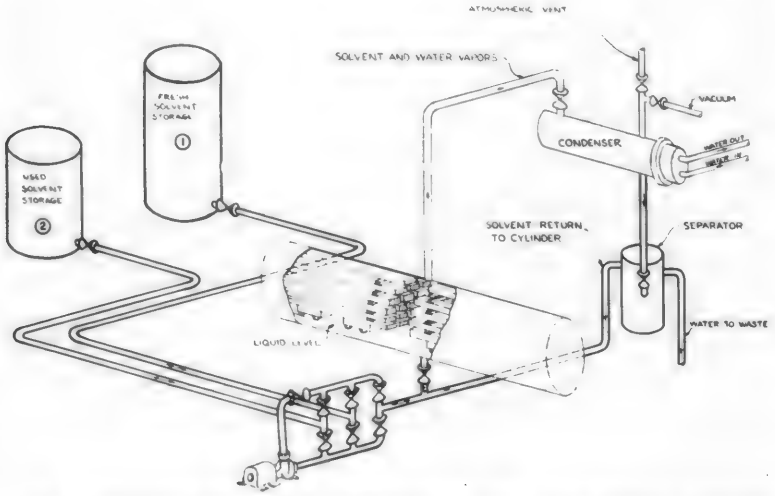

Fig. 1.—Pressure impregnating cylinder showing in heavy lines additional equipment required for vapor drying or vapor solvent recovery.

Drying Results of Each Species

Douglas-fir: Vapor drying at atmospheric pressure and at temperatures from 240° to 260° F. reduced the moisture content of 1-in. Douglas-fir from 50 to 10 per cent in only 5–6 hours. There was very little degrade due to warping or checking, but about 15 per cent of the knots were loosened or fell out. This 1-in. material was all No. 3 common and those knots that fell out were small encased knots, held in place by small amounts of resin. The washing action of the condensed hydrocarbon evidently removed the resin from the wood, leaving the knots loose.

Drying at temperatures above 225° F. tended to cause severe honeycombing in Douglas-fir material which was 2-in. or thicker and when it was dried to low moisture contents. Satisfactory results were obtained with this thicker material when drying was carried out at 225° F. temperatures and under a vacuum of 17.5 inches of mercury.

All of the vapor dried Douglas-fir exhibited steep moisture gradients and generally severe casehardening. Conditioning periods of one or two hours did not relieve these stresses. With low drying temperatures there was no evidence of honeycombing in this material immediately after drying. However, after one or two months storage in the lab, practically all the boards and timbers exhibited internal checks. Drying conditions and data for the vapor drying tests on Douglas-fir are presented in Table 1.

As was the case with all species, the amount of shrinkage which occurred in Douglas-fir lumber during vapor drying did not vary appreciably with that which has been reported for kiln dried material.

There was only very small incidence of surface and end checking in any of the Douglas-fir, even in the 7 x 9-in.

[1] Presented at Session II, Wood Drying, Ninth National Meeting, FPRS, June 21–24, 1955, in Seattle, Wash. Read by Leif D. Espenas, Oregon Forest Products Laboratory, Corvallis.

[2] Numbers in parentheses refer to literature cited.

The Author: W. R. Cantrell received B.S. in 1947 from Wofford College, Spartanburg, S. C. A Navy veteran of World War II, he is a member of American Chemical Society and American Wood Preservers Assoc.

Table 1.—VAPOR-DRYING TESTS ON DOUGLAS-FIR

No. of Chgs.	Board Thickness Inches	Type of Cycle	Drying Agent	Effluent Vapor Temp. °F.	Average Moisture Content* Initial	Final	Drying Time Hours	Drying Agent* Retention	Vacuum In. Hg.
1	1	St.‡	X‖	251	44	9	4.6	0.7	0
1	1	Alt.§	X	248	55	9	5.0	0.7	0
1	1	St.	P #	236	50	13	7.0	1.4	0
1	1	St.	X	221	52	13	5.5	0.4	10
1	2	St.	X	260	35	8	8.5	0.5	0
1	2	St.	X	260	37	8	12.0	0.1	0
1	2	St.	X	240–260	38	7	14.5	0.5	0
1	2	St.	X	240–260	38	7	13.0	0.4	10 to 0
1	2	Alt.	X	256	44	11	8.8	0.6	0
1	2	St.	P	246	42	17	11.8	0.1	0
1	2	St.	X	240	39	9	13.0	0.5	0
1	2	St.	X	240	36	6	30.0	1.9	0
1	2	St.	X	240	35	9	11.0	0.5	10
1	2	St.	X	240	40	9	12.8	0.3	12.5
1	2	St.	X	230	27	16	10.0	0.3	0
1	2	St.	X	229	35	10	13.0	0.9	15
1	2	Alt.	X	227	38	13	11.8	0.5	15
1	2	St.	X	223	34	10	13.0	0.4	17.5
1	2	St.	X	208	32	10	8.0	1.9	20
1	2½	St.	P	252	29	8	14.8	---	0
1	2½	St.	X	224	29	9	9.5	---	17.5
1	2½	St.	T**	191	28	7	92.3	.	0
1	4	St.	X	240	29	10	24.0	---	10
1	4	St.	X	225	35	16	25.0	.	17.5
1	4	St.	X	220	27	12	23.5		16
1	6	St.	X	250	45	33	12.5	---	0
15	7	St.	X	260	43	25	8.0	---	0
				KILN-DRIED DOUGLAS-FIR					
1	4	----	----	152 DB†† 137 WB‡‡	37	16	260	---	-- -
1	4	----	----	202 DB 186 WB	34	16	164	--	.

*Per cent based on oven-dry weight.
†These charges run using forced circulation.
‡Straight.
§Alternating.
‖Xylene.
#Perchloroethylene.
**Trichloroethylene.
††Dry-bulb temperature.
‡‡Wet-bulb temperature.

boxed-heart crossties. The absence of checking and splitting in the vapor dried ties as compared with their air-dried counterparts is demonstrated in Figure 2.

Chemonite Treated Douglas-fir: One of the chief disadvantages of lumber preservatively treated with a water-borne salt is the fact that before being put into many types of construction, it should be dried. Since the Vapor Drying Process can be used to dry this material in the same vessel in which it was impregnated, handling costs can be reduced.

Several charges of 2-in. and 4-in. Douglas-fir which had been Chemonite-treated were vapor dried with no internal checking and with very little surface or end checking. Data for these charges can be found in Table 2. The 2-in. material required approximately 6 hours to dry and the 4-in. approximately 10 hours.

The moisture content in 10-in. diameter poles could be reduced from 78 to 25 per cent in about 25 hours. None of the vapor dried poles exhibited checks which extended into the untreated wood.

Chemonite Treated White Fir: Temperatures below 250° F. were necessary in drying this material in order to eliminate honeycombing. A drying time of 27 to 30 hours could be expected for drying white fir to a moisture content of 18 or 19 per cent. There was very little checking in this material, but there was evidence of some very slight collapse.

Sugar Pine: The 1-in. material was dried in the 1- by 10-foot cylinder at the OFPL, and the 2-, 3-, and 4-in. pine were dried in the 18-inch by 6-foot cylinder at Spartanburg, S. C. Table 2 gives vapor drying data on all west coast pines which were investigated.

There were no serious defects in the 1-inch vapor dried material, but in the thicker material there was a darkening of the wood at temperatures above 270° F. The 4-inch pine honeycombed in both charges listed in Table 2.

Ponderosa Pine: An alternating cycle, using an effluent vapor temperature of 250° F., reduced the moisture content from 120 to 7 per cent in 7 hours. The alternating cycle was necessary in order to keep drying agent retentions to a minimum.

There was a fairly wide range of

Fig. 2.—Group of 20 matched Douglas-fir 7 x 9 crossties. The group of 10 on the left were vapor dried and treated, the group of 10 on the right were air seasoned and treated.

moisture contents of boards within a charge, which might have been overcome to a degree by the drying of heartwood boards in separate charges from sapwood boards, and by the use of an equalizing cycle similar to that used in kilns. The equalizing cycle and conditioning cycle would very likely reduce the high moisture gradients experienced in vapor drying ponderosa pine.

"Brown stain" was present in most of the boards; however, it was not possible to determine its cause in this lumber.

Jack Pine: The 7- by 9-inch tie material was vapor dried in 12 hours, and pressure treated in another 6 hours with a net retention of 8.6 lb./cu. ft. of a creosote-petroleum mixture. Like the Douglas-fir ties, these ties were exceptionally free of surface and end checking. Where less desirable species, such as jack pine, can be successfully dried and treated, their use can mean cheaper crossties.

Western Hemlock: All data on western hemlock can be found in Table 3 and were obtained from the vapor drying work of Lansell at the OFPL. Lansell demonstrated that by varying temperature and pressure in the drying chamber, equilibrium moisture contents were varied from 6.0 to 0.7 per cent. As would be expected, high temperatures in combination with pressures producing low relative-humidity conditions caused most rapid drying. These drying conditions also produced the greatest amount of internal checking, but with an increase in the humidity, internal checking could be eliminated even with drying temperaturees of 265° F. Temperatures in excess of 260° F. caused a darkening of the lumber throughout its thickness.

Lansell reports that a 20 to 24 hr. drying cycle for 2-in. western hemlock might be expected. An equalization and conditioning treatment would be necessary after the drying cycle in order to produce uniform drying to a final desired moisture content of 6 to 10 per cent.

Redwood: Included here are data gathered by Lansell in some exploratory work on vapor drying of redwood. According to the data in Table 3, 1-in. redwood could be vapor dried from an

Table 2.—VAPOR-DRYING TESTS ON VARIOUS SOFT WOODS

No. of Chgs.	Dimensions Inches	Type of Cycle	Drying Agent	Effluent Vapor Temp. °F.	Average Moisture Content* Initial	Average Moisture Content* Final	Drying Time Hours	Drying Agent Retention*	Vacuum In. Hg.
			CHEMONITE TREATED DOUGLAS-FIR						
2	2 x 4	St.†	X§	260	70	20	5.0	----	0
1	2 x 6	St.	X	250	55	17	8.5	1.7	0
1	4 x 4	St.	X	250	50	15	9.5	0.5	0
2	10" dia. poles	St.	X	260	78	25	25.0	----	0
			CHEMONITE TREATED WHITE FIR						
1	4 x 4	Alt.‡	X	260	100	12	20.5	0.3	0
1	4 x 6	St.	X	257	152	33	18.0	0.3	0
1	4 x 6	St.	X	246	164	25	27.5	1.0	7
			SUGAR PINE						
1	1	Alt.	X	260	220	5	9.0	----	0
1	2	St.	X	277	230	3	27.0	Neg.	0
1	2	St.	K-4	323	203	1	21.0	2.3	0
1	3	St.	X	267	230	92	17.0	Neg.	0
1	3	St.	X	274	230	8	55.0	Neg.	0
1	4	St.	X	277	226	4	97.0	Neg.	0
1	4	St.	K-4	333	238	1	71.0	1.8	0
			PONDEROSA PINE						
5	1	St.	X	256	113	4	9.0	14.2	0
4	1	Alt.	X	251	126	7	7.0	1.5	0
1	1	St.	X	212	83	16	7.0	8.4	15
			JACK PINE						
9	7 x 9	St.	X	260	58	30	12.0	----	0

*Per cent based on oven-dry weight.
†Straight.
‡Alternating.
§Xylene.
‖Coal tar fraction-boiling range 300° to 395° F.

Table 3.—VAPOR-DRYING TESTS ON 2-INCH WESTERN HEMLOCK AND 1-INCH REDWOOD

No. of Chgs.	Absolute Pressure Mm Hg.	Observed E.M.C. Per cent	Drying Agent	Effluent Vapor Temp. °F.	Average Moisture Content* Initial	Average Moisture Content* Final	Drying Time Hours	Drying Agent Retention*	Average Diffusion Constant In.†/hr.
				WESTERN HEMLOCK					
1	1200	0.7	X†	290	47	9	12.0	0.5	.098
1	1200	2.2	X	265	44	15	21.5	Neg.	.031
1	1200	2.8	X	240	48	23	31.5	0.6	.013
1	760	--	X	260	63	16	13.3	0.5	---
1	760	--	X	240	59	18	20.3	Neg.	---
1	760	2.1	X	240	62	21	23.0	0.5	.030
1	760	--	X	240-265	57	21	15.0	0.3	---
1	600	1.4	X	245	49	15	23.0	0.1	.032
1	600	2.3	X	225	53	19	33.0	0.1	.021
1	600	4.4	X	205	55	19	48.0	1.6	.015
1	300	2.0	X	210	42	12	28.5	0.8	.031
1	300	2.6	X	190	40	12	56.5	1.3	.015
1	300	5.7	X	170	46	18	82.8	2.1	.009
1	150	3.6	X	170	46	20	33.5	0.3	.017
1	150	3.9	X	155	50	20	75.5	1.4	.008
1	150	6.0	X	140	47	19	114.5	1.4	.006
1	75	4.4	X	140	41	18	66.3	0.2	.005
1	760	--	K‡	240	47	12	20.0	0.2	---
1	Kiln dried	2.5	----	DB 170§ WB 115‖	38	18	47.5	----	.009
1	Kiln dried	3.0	----	DB 140 WB 92	40	17	85.0	----	.006
				REDWOOD					
1	760		X	250	140	40	7	---	---
2	250	---	X	180	180	12	70	0.8	---
1	100	---	X	150	143	24	58	0.8	---

*Per cent based on oven-dry weight.
†X = Xylene.
‡K = Kerosene.
§DB = Dry-bulb temperature.
‖WB = Wet-bulb temperature.

initial moisture content of 140 per cent to a 10 per cent final moisture content in about 90 hours with very few drying defects. A steep moisture gradient would very likely exist in this vapor dried redwood just as it would in a kiln charge dried under similar conditions. Temperatures of 250° F. caused severe collapse and honeycombing, but the material dried at 150° and 180° F. eliminated the honeycombing and greatly reduced the amount of collapse.

Western Larch: The 1-in. lumber dried very fast and with few defects. However, the 2-in. and 4-in. lumber honeycombed at temperatures of 250° F. and above. Table 4 gives data obtained from these tests. Moisture was exceptionally difficult to move from the cores of the thicker material. The galactin content of these boards was high, and the high temperatures tended to caramelize them, giving the wood a burnt-sugar odor and a dark brown coloration.

The crosstie and pole material treated better when vapor dried for short lengths of time and at the higher moisture contents. Very erratic and poor penetration of the preservative occurred when this type of material was dried to low moisture contents (25 to 30 per cent). Even when vapor dried to low moisture contents, the tie and pole material exhibited very few surface or end checks.

Madrone: Vapor drying data on all the hardwoods included in this study can be found in Table 4. Very rapid drying of madrone was accomplished with very little degrade. Under a vacuum of 20 inches and at 210° F., this species was vapor dried from 94 per cent moisture content to 12 per cent in 17 hours. The most serious defect was a reddish discoloration on the surface running to a depth of approximately 1/8 inch in the boards. This discoloration was attributed to an accumulation of "extractives" at the drying surfaces which had moved with the water to the surface and been left behind as the water evaporated. The high temperatures had evidently caused these extractives to become fixed since attempts to leach them from the wood failed.

There was some collapse and honeycombing present, but not enough to be of any major concern.

California Black Oak: The one charge of this species which was vapor dried reacted very badly to the drying conditions of 20 inches of mercury vacuum and 210° F. effluent vapor temperature. All boards were severely honeycombed and collapsed. Lack of time and materials made further work on this species impossible at that time.

Tan Oak: Only one charge of this species of wood was run. Like the madrone, there was some collapse and honeycombing, but no more than has been encountered in kiln drying green tan oak. Recirculation of vapors was used for this charge as was done in some of the hemlock work. At 180° F. effiuent vapor temperature under a vacuum of 20 inches of mercury, it took 30 hours to dry from an initial moisture content of 80 per cent to a 10 per cent final moisture content.

Equipment Costs

Little thought or effort has been given to designing a unit for the sole purpose of vapor drying lumber. All units designed to date have been for drying in conjunction with pressure treatment and therefore the drying vessel was cylindrical in shape and of heavy construction.

Equipment and installation costs for a vapor drying plant with a capacity of 6,000 B. F. are approximately $60,000. This figure includes a boiler plant at $12,000. A plant this size would have a daily throughput of 24,000 B.F. of 1-in. Douglas-fir or 18,000 B.F. of 1-in. ponderosa pine. Plants with two, three or four times this capacity can be built which cut the cost per unit throughput considerably. For example, where pine is being dried, the cost per unit throughput on the small plant above would be approximately $3,300, whereas on a plant costing $90,000 with a capacity of 30,000 B.F., the cost per unit throughput amounts to only $1,000.

Operational Costs

The capacity of the drying cylinder, species being dried, local labor and material costs affect to a large extent the actual cost of operation. Therefore, no attempt will be made to present a cost per M.B.F. for vapor drying any one species of lumber. Below are listed items which must be considered in comparing vapor drying costs with kiln-drying costs:

1. Approximately 0.5 lb. of the drying agent is lost per cubic foot of wood processed. Suitable drying agents can usually be bought for about $ .20 to $ .25 a gallon, and weigh about 7 pounds per gallon.
2. Steam consumption varies from 2,000 to 3,000 lb. per M.B.F. depending on type of material being dried. This steam must be at 150 psi or above.
3. Electric power would amount to between $ .10 and $ .20 per M.B.F., depending on size of plant.
4. Water costs (condenser) would be approximately $ .10 to $ .15 per M.B.F.
5. Plant is depreciated on 15 year basis.

Table 4.—VAPOR-DRYING TESTS ON WESTERN LARCH AND SOME WEST COAST HARDWOODS USING XYLENE AS A DRYING AGENT

No. of Chgs.	Board Thickness Inches	Type of Cycle	Effluent Vapor Temp. °F.	Average Moisture Content* Initial	Average Moisture Content* Final	Drying Time Hours	Drying Agent Retention*	Vacuum In. Hg.
			WESTERN LARCH					
3	1	St.	250	48	16	6.3	0.7	0
2	2	St.	250	47	12	13.8	0.6	0
1	2	St.	225	46	19	16.5	0.5	17.5
1	4	St.	225 to 260	43	13	67.0	0.5	17.5 to 0
1	4	St.	220	42	26	30.8	0.5	17.5
9	7 x 9	St.	260	83	48	17.0		0
3	8" dia. poles	St.	250	67	50	5.0		0
6	Poles	St.	250	67	30	11.0		0
1	Poles	Alt.	250	82	36	12.4	---	0
			MADRONE					
4	1	Alt.	210	94	12	17.0	2.0	20
			CALIFORNIA BLACK OAK					
1	1	Alt.	210	95	23	13	---	20
			TAN OAK					
1	1	St.	180	80	14	31	2.7	20
			RED ALDER					
1	1	St.	250	100	13	6.5	---	0
1	1	St.	225	130	23	10.0	---	17.5
1	1	Alt.	250	105	13	16.0	---	0

*Per cent based on oven-dry weight.

6. Annual maintenance amounts to about 2 per cent of the equipment cost.
7. Fire insurance rates are about $ .60 per $100.
8. One operator is required on the job at all times, and his rate of pay would be $1.50 to $1.75 per hour.
9. Royalty rates for lumber are on a sliding scale:
   $2.00/M.B.F. for 1st 2,000,000 B.F.
   $1.65/M.B.F. for next 3,000,000 B.F.
   $1.25/M.B.F. for all over 5,000,000 B.F. of lumber vapor dried in a 12-months period.

Royalty charges for poles, crossties or large timbers dried in preparation for preservative treatment are at the rate of $ .015 per cu.ft. of wood.

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Chemical Resistance of Western Woods[1]

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The resistance of different wood species to chemical solutions is an important factor in selecting wood for storage tanks. Thirteen western woods and two southern woods were exposed to solutions of several common acids, bases, and salts at room and boiling temperatures to measure their relative chemical resistance. Extent of deterioration was determined by comparing final average breaking load for each species with average breaking load for untreated pieces.

Introduction

THE SELECTION OF A WOOD to withstand the action of various chemical solutions encountered in using wooden process equipment is often a problem. This is especially true if it is desired to consider species other than the conventional tank woods. Under present conditions, the problem is not too critical, since supplies of lumber are generally ample. However, during times of emergency, increased demand brings a search for substitute woods to replace both metal and standard tank woods that are commonly used in process equipment.

The consumption of wood for tanks, pipe, and related equipment is by no means small. Figures given by the Census Bureau show the volume of tank lumber used has increased markedly, from 22.9 million board feeet in 1933 to 63.8 million in 1948.

The species comprising these totals are primarily Douglas-fir, redwood, southern yellow pine, and cypress, these woods having been long-preferred in this field. However, there is no reason to believe that other species might not be serviceable for use with some industrial chemicals. The Oregon Forest Products Laboratory therefore undertook a preliminary investigation of a number of western softwoods in order to determine their resistance to chemical attack.

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Review of Literature

An extensive literature survey was made, but did not disclose much information applicable to western species. Most prior work can be grouped in three classes: service records on wooden equipment, maintained either by users or manufacturers; laboratory investigations on chemical resistance of woods, modeled after conditions encountered in service; fundamental organic chemical studies to determine the properties of various woods that make them resistant or non-resistant to chemical action.

Service records on wooden process equipment are important since they, of course, give the final answer as to whether a wood is suitable for a given use. Such records, however, seldom cover the possible applications under consideration. The California Redwood Association has published an excellent bulletin on service records of redwood tanks, but the records are of little assistance where other species are concerned (4).[2]

The fundamental organic studies on resistance are the most rare and in some respects the most interesting (2). There have been a few attempts to predict, and considerable speculation on the possibilities of predicting chemical resistance from analytical data. While some generalizations have been made from this type of work and related investigations on the chemistry of pulping and hydrolysis, the basic reasons why one wood resists chemical attack differently from another are still not well explained.

[2] Numbers in parentheses refer to literature cited.

Laboratory studies simulating service conditions have been the most popular means for studying the resistance of woods, but much of this prior work does not evaluate resistance in terms that are directly applicable (3, 5). This type of study, however, does provide some indication of the properties of woods when exposed to chemical attack, although it does not necessarily disclose the reasons for, or lack of, resistance. Such an approach was used as the basis for this study.

One aim of the study was to obtain more absolute means for evaluating extent of chemical attack. Such tests as manual flexing, visual observations, and fingernail tests for hardness do not prove of much benefit when selection of a resistant wood is necessary. An excellent report "Wood as a Chemical Engineering Material" was given in 1954 at the annual meeting of the Forest Product Research Society by Roy Baechler of the U. S. Forest Products Laboratory (1). While the objectives and procedure were somewhat different from the present work, the basic aim of providing numerical data on relative chemical resistance was followed.

Experimental Procedure

Woods Tested: The species selected for testing were: Douglas-fir, *Pseudotsuga menziesii;* white fir, *Abies concolor;* noble fir, *Abies procera;* western red cedar, *Thuja plicata;* in-

cense cedar, *Libocedrus decurrens;* Port Orford cedar, *Chamaecyparis lawsoniana;* sitka spruce, *Picea sitchensis;* west coast hemlock, *Tsuga heterophylla;* western larch, *Larix occidentalis;* ponderosa pine, *Pinus ponderosa;* sugar pine, *Pinus lambertiana;* Idaho white pine, *Pinus monticola;* and redwood, *Sequoia sempervirens.* In addition, specimens of bald cypress, *Taxodium distichum,* and southern yellow pine, *Pinus palustris,* were included for comparison.

Solutions: The woods were exposed to water and water solutions of acids, bases, and salts both boiling and at room temperature, and a bleach at room temperature. Duration of exposure was arbitrary, depending on the apparent extent of deterioration in the specimens.

Room-temperature Solutions: Sodium hydroxide, sodium carbonate: 1, 10, and 20 per cent; hydrochloric, sulfuric, nitric, and acetic acids: 5 and 20 per cent; sodium chloride and calcium chloride: 5 and 20 per cent; sodium hypochlorite: 5 ¼ per cent; and saturated lime water: water.

Boiling Solutions: hydrochloric, nitric, and sulfuric acid: 1 per cent; sodium hydroxide: 1 per cent; sodium carbonate; 5 per cent; and water.

Preparation, Exposure, and Testing of Specimens: The test procedure can be explained best by a chronological tabulation of the steps followed:

1. A single piece, 2 by 6 inches by 8 feet, of each species was selected for uniformity and high quality, and about 100 pieces ¼ by ¾ by 8 inches in size were cut from each. Test specimens were cut to place the vertical grain on the ¾-inch face.

2. Two specimens from each species were selected for each solution under consideration. The pieces were stamped with code numbers. For ponderosa pine, however, only one piece each of heartwood and sapwood was used.

3. The pieces were conditioned to about 12 per cent moisture content on a dry-weight basis.

4. After conditioning, the pieces were weighed and the three dimensions measured with a micrometer jig.

5. Two pieces of each species were immersed on end and weighted down in 4-liter beakers containing about 1 gallon of solution.

6. The specimens were removed periodically and a partial load-deflection curve determined. If there was not much decrease in strength, the specimens were returned to the respective solutions.

7. When sufficient deterioration had occurred to make noticeable differences in properties of the woods, the wet specimens from each batch were tested to breaking, and the complete load-deflection curve plotted.

8. At the time of the breaking tests, the weight and dimensions of each specimen were determined again.

9. After being broken in the wet condition, the specimens were air-dried, then conditioned at 65 per cent relative humidity and 70° F., and dimensions again determined.

10. The specimens then were oven-dried, and the oven-dry weight used to calculate a final weight at around 12 per cent moisture content.

Table 1.—PERCENTAGE OF ORIGINAL WET BREAKING STRENGTH REMAINING AFTER EXPOSURE TO ACIDS FOR THE DURATION INDICATED

Species	Room Temperature								Boiling		
	Sulfuric		Hydrochloric		Nitric		Acetic		Hydrochloric	Sulfuric	Nitric
	5% 105 days	20% 62 days	5% 71 days	20% 23 days	5% 72 days	20% 41 days	5% 176 days	20% 94 days	1% 36 hours	1% 36 hours	1% 36 hours
	Per cent										
Douglas-fir	91	83	67	22	65	20	99	94	59	67	59
White fir	97	74	68	29	65	23	102	89	47	68	57
Noble fir	98	55	76	32	78	27	109	90	54	70	61
Western red cedar	82	84	71	29	59	21	94	72	62	70	66
Incense cedar	90	64	52	31	60	29	85	85	59	57	57
Port Orford cedar	84	72	68	31	71	28	94	79	57	67	61
Ponderosa pine—heart	90	61	64	26	71	16	98	67	53	66	49
Ponderosa pine—sap	98	63	77	*	65	27	100	81	63	88	73
Sugar pine	86	69	65	27	62	23	87	76	51	62	53
Idaho white pine	86	63	68	29	67	24	95	82	52	63	53
West Coast hemlock	92	66	68	28	67	26	100	87	47	63	50
Sitka spruce	94	74	70	31	66	22	94	82	53	73	53
Western larch	85	72	66	24	58	16	102	83	48	51	53
Cypress	84	65	66	33	80	27	96	77	59	71	59
Redwood	86	67	65	27	77	20	93	78	58	71	58
Southern pine	92	67	73	27	56	28	102	82	44	59	44

*Test specimen broke in handling before test.

Evaluation of Test Data

In order to compare the change in strength properties occurring during exposure to the various solutions, the average load-deflection curve for each two treated specimens was compared with an average curve obtained by breaking untreated, water-soaked specimens of each species. All pieces were tested in the same manner on a Tinius–Olsen machine, using a 6-inch span and head speed of 0.125 inch per minute. The machine was equipped with a Tate–Emery air cell, and a load range of 0–200 pounds was used, permitting readings to 0.5 pound.

In addition to the breaking load, data were also calculated for change in strength in the proportional limit load, and change in area under the load-deflection curve at the maximum load.

The data recorded for the test procedure contained information as to changes in: breaking load caused by treatment; load-carrying ability in proportional limit range; area under load-deflection curve at maximum load; specimen weight, width, and thickness from original to wet-treated condition; specimen weight, width, and thickness from original to dry-treated condition; and length (for some treatments).

Only the values on breaking load are presented here since they were selected as the best means for judging the relative resistance of the woods. The other figures, particularly dimensional changes, may be as important for some uses as breaking strength, but the space occupied by the complete data is too great to permit inclusion here. Solution concentration, temperature, exposure time, and breaking loads as percentages of original strength are listed in Tables 1, 2, 3, and 4.

An average of residual strengths for each species when exposed to action of acids, bases, and salts, is shown in Table 5.

Results and Discussion

The work covered considerable area at the expense of using a small number of specimens. While it certainly would be desirable to carry out such a project using enough specimens to permit a statistical analysis of the problem, the limitations imposed by personnel, funds and working space made it necessary to hold down the size of the project.

It should be stressed that the results apply to the particular wood samples used, and may or may not be representative of the species. If chemical resistance is governed primarily by inherent properties of the wood components, probably the results were fairly reliable. If, however, the extraneous materials, specific gravity, or growing conditions have much influence, chemical resistance may vary considerably within a species. In any event, this work should be followed up with a more detailed examination of a few woods to determine variation within a species.

It should be noted also that according to the arbitrary system of evaluation used here, a strong wood may have lost a greater percentage of the strength than did a weaker wood, and

still have retained greater absolute strength than did the weaker wood.

Acids: Nitric and hydrochloric acids were the most destructive to the woods; each showed similar effects in both 5 and 20 per cent solutions. Sulfuric acid was much less active and showed only a little reaction in 5 per cent solution and moderate attack in 20 per cent solution. Acetic acid had little action in 5 per cent solution, but a noticeable weakening of woods occurred in 20 per cent solution. Boiling 1 per cent solutions of hydrochloric and nitric acids showed similar results, and 1 per cent sulfuric acid caused somewhat lower strength loss.

Among the individual woods, the true firs generally showed relatively high resistance, and the conventional tank woods were slightly lower in residual strength. One rather curious result was the good performance of ponderosa pine sapwood. This showing might result from experimental error, since only one piece of sapwood was used in each batch. Another rather strange result was the good showing of southern yellow-pine in room-temperature solutions and its poor performance in boiling acid solutions.

Bases: All woods showed typical flexibility after exposure to strong bases. The true firs gave fairly good performances, as did Douglas-fir, cypress, and southern pine. Redwood showed rather erratic results, and ponderosa pine sapwod again proved relatively good. In 20 per cent sodium hydroxide, a distinct shrinkage in specimen length was noted (Figure 1). This longitudinal shrinkage is apparently explained by fiber-swelling phenomena which have been described previously by a number of authors (6).

Salts: Not much can be determined by strength data derived from the salt solutions. Many of the woods in nondestructive salt solutions showed increases in strength, apparently because of crystallization within the wood structure. It is interesting to note that dilute solutions of sodium carbonate apparently caused greater strength loss than did more concentrated solutions. The bleach solution was a rather special case since this reagent caused more apparent destruction of the wood than did any other solution (Figure 2). The concentration was probably too high, but results were quite interesting. Southern pine and cypress were far superior to other woods, with incense cedar and Port Orford cedar best of the western woods.

Water: All specimens showed strength losses of about the same magnitude in boiling water, but results from room-temperature water soaking were quite erratic. The small size and number of test specimens used may have contributed to the variation shown in Table 4.

General Observations

In general, the spread between strength properties of the species was not great, as indicated by average breaking loads in Table 5. The woods usually considered to have highest chemical resistance did not show consistently better properties than those of some of the lesser known woods. This finding leads to the conclusion that biological resistance may be more important than chemical resistance in some uses. There has been some confusion in the past over the cause of failure in wooden equipment and biological attack frequently has proved to be the major offender.

The generally good performance of the true firs was rather surprising.

Table 2.—PERCENTAGE OF ORIGINAL WET BREAKING STRENGTH REMAINING AFTER EXPOSURE TO BASES FOR THE DURATION INDICATED

Species	Room Temperature: Sodium hydroxide 1% 87 days	Room Temperature: Sodium hydroxide 10% 79 days	Room Temperature: Sodium hydroxide 20% 22 days	Room Temperature: Calcium hydroxide saturated 151 days	Boiling: Sodium hydroxide 1% 36 hours
	Per cent				
Douglas-fir	51	26	6	105	42
White fir	59	33	12	97	52
Noble fir	62	38	9	94	59
Western red cedar	40	23	5	90	40
Incense cedar	39	24	5	110	41
Port Orford cedar	48	26	7	82	51
Ponderosa pine—heart	43	27	9	87	53
Ponderosa pine—sap	63	29	8	96	83
Sugar pine	33	22	4	85	42
Idaho white pine	54	29	3	87	49
West Coast hemlock	59	35	10	92	47
Sitka spruce	52	30	9	98	43
Western larch	40	29	5	89	40
Cypress	54	35	14	102	53
Redwood	34	24	10	94	43
Southern pine	53	34	18	91	60

Table 3.—PERCENTAGE OF ORIGINAL WET BREAKING STRENGTH REMAINING AFTER EXPOSURE TO SALTS FOR THE DURATION INDICATED

Species	Room temperature: Sodium carbonate 1% 175 days	Sodium carbonate 10% 154 days	Sodium carbonate 20% 93 days	Calcium chloride 5% 178 days	Calcium chloride 20% 105 days	Sodium chloride 5% 179 days	Sodium chloride 20% 161 days	Boiling: Sodium hypochlorite 5¼% 21 days	Sodium carbonate 5% 36 days
	Per cent								
Douglas-fir	80	99	111	109	106	104	107	32	56
White fir	91	94	109	118	125	107	118	25	63
Noble fir	97	97	108	115	119	109	118	13	70
Western red cedar	73	74	84	96	120	100	121	25	43
Incense cedar	82	88	84	105	93	84	102	48	55
Port Orford cedar	81	87	99	101	118	106	110	43	56
Ponderosa pine—heart	79	96	92	100	93	89	98	22	52
Ponderosa pine—sap	88	96	98	110	115	111	113	4	94
Sugar pine	80	93	103	103	98	95	113	18	45
Idaho white pine	86	88	100	100	100	104	104	17	63
West Coast hemlock	82	91	107	102	108	95	103	12	56
Sitka spruce	89	93	104	108	115	105	112	29	56
Western larch	91	88	86	95	125	104	93	20	51
Cypress	88	91	106	108	108	100	110	51	64
Redwood	80	83	98	100	111	105	104	24	47
Southern pine	81	77	112	123	89	99	94	60	65

Table 4.—PERCENTAGE OF ORIGINAL WET BREAKING STRENGTH REMAINING AFTER EXPOSURE TO WATER FOR THE DURATION INDICATED

Species	Room temperature 189 days	Boiling 80 hours
	Per cent	
Douglas-fir	102	76
White fir	109	89
Noble fir	114	82
Western red cedar	96	78
Incense cedar	86	90
Port Orford cedar	98	87
Ponderosa pine—heart	94	67
Ponderosa pine—sap	104	81
Sugar pine	99	76
Idaho white pine	98	73
West Coast hemlock	91	76
Sitka spruce	97	86
Western larch	97	80
Cypress	103	85
Redwood	105	77
Southern pine	99	92

Table 5.—AVERAGE PERCENTAGES OF ORIGINAL (WET BREAKING STRENGTH) AFTER EXPOSURE TO DIFFERENT CLASSES OF SOLUTIONS

Species	Average residual breaking strength: Acids	Bases	Salts
	Per cent		
Ponderosa pine—sap	69.5	55.8	9 .1
Noble fir	68.2	52.4	9 .0
Douglas fir	66.0	46.0	8 .3
White fir	65.3	50.6	9 .4
Cypress	65.1	51.6	9 .8
Sitka spruce	64.7	46.4	9 .1
Port Orford cedar	64.7	42.8	8 .8
Western red cedar	64.5	39.6	8 .7
Redwood	63.7	41.0	8 .6
West Coast hemlock	63.1	48.6	8 .0
Idaho white pine	62.0	44.4	8 .7
Sugar pine	61.2	37.2	8 .1
Incense cedar	60.8	43.8	8 .3
Ponderosa pine—heart	60.0	43.8	8 .1
Southern pine	60.0	51.2	8 .8
Western larch	59.8	40.6	8 .7

However, while these species showed high chemical resistance, they are known to have low biological resistance. This suggests that a superior chemical lumber might result from a preservative treatment of such woods, if treatments can be developed that are compatible with the various solutions that may be in contact with the wood.

Concluding, this preliminary study has indicated the possible utility of some relatively unknown western species as materials of chemical construction. Further work is advisable to check the results. In addition, the need for standardized tests to evaluate the resistance of woods to chemical attack again has been emphasized.

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Discussion

S. B. Preston (U. of Michigan): Would a toughness test put the treated samples in the same order as did the cross breaking strength?

Mr. Ross: We measured areas under the load-deflection curves which should correspond to a toughness test. There was only a very rough correlation with breaking strength.

E. Ellis (U. of Idaho): No mention was made of loss of mass or weight, or change of dimension. This problem seems to be largely a surface matter and brings up the validity of a mechanical test as a measure of chemical resistance.

Mr. Ross: Figures are given in the complete report on changes in weight and dimension. As for the method of testing, we felt that any chemical attack would be reflected as loss in breaking strength.

S. B. Preston: Why did you select loss breaking strength as a property to use in evaluating the influence of chemicals on wood?

Mr. Ross: Mainly because of the available testing machinery. We initially attempted to use a toughness test but found that samples which had been exposed to basic solutions were too soft to test in the toughness machine. Cross-breaking strength seemed to give the most consistent results and could be applied to samples in any condition. There may, however, be better methods for evaluating chemical resistance. We seriously considered tests using either crushing strength or permeability changes since these properties are of more practical importance in pipe and tank construction.

Fig. 1.—Decrease in length of test specimens caused by exposure to 20 per cent sodium hydroxide solution for 22 days. Upper piece in each group was untreated.

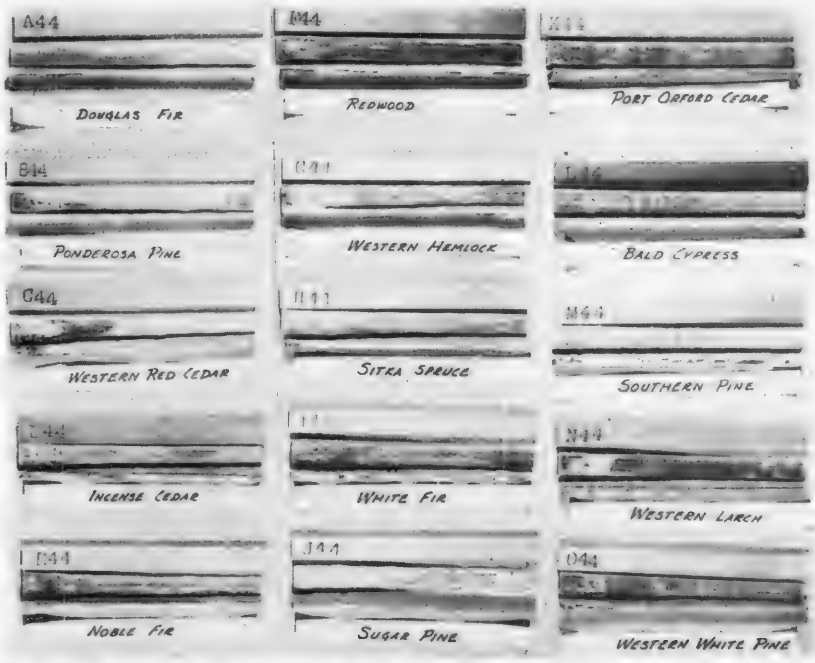

Fig. 2.—Extreme surface attack caused by exposure to 5.25 per cent sodium hypochlorite solution for 21 days. Upper piece in each group was untreated.

Sodium Arsenite as a Debarking Agent for Hemlock Trees Causes Serious Loss of Tannin in the Bark[1]

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Sodium arsenite used as a debarking agent for hemlock trees causes a loss of about 30 per cent of tannin in the bark. The effect is not localized but is distributed throughout the height of the tree. Results of the study indicate a need to investigate other debarking chemicals and methods of application.

HAND PEELED BARK from eastern hemlock trees has been an important source of vegetable tannin in North America for more than 100 years. In the early days hemlock trees were cut down for the sole purpose of recovering the bark. Many tanneries sprang up in the proximity of large stands of eastern hemlock. As these stands were exhausted and it became too costly to transport the bark great distances, many of these closed until today we find very few tanneries leaching their own bark.

The amount of tannin produced from hemlock bark is small compared with the amount of tannin derived at present from chestnut wood (our main domestic source) in this country. However, it is desirable to develop new domestic sources of tannin because practically all of the virgin stands of chestnut have been killed by blight.

Confronted with this situation and the fact that close to 90% of the vegetable tannin used in this country must be imported, our national defense authorities place vegetable tannin high on the list of critical materials necessary for a successful war effort.

In order to increase the domestic production of tannin, investigations have been made of such materials as barks from the Florida scrub oaks and the mixed oaks of the Tennessee Valley, canaigre roots from the southwest, barks of hemlock and Douglas-fir from the Pacific Coast. To the foregoing should be added a research project now underway to determine the feasibility of producing hemlock tannin extract from wastes of the logging and pulping industries in the Upper Peninsula of Michigan.

As has already been indicated, the cost of delivering bark to the tannery or extract plant is one of the most important factors governing its continued use as a source of vegetable tannin. Practically all hemlock bark used in the United States today comes from the peeling of logs used for pulp by paper mills in Northern Michigan and Wisconsin. The peeling season in this area for eastern hemlock and other pulpwood species, when bark may be easily removed, is limited to a maximum of three months, usually from mid-May to the middle of August. This time limitation for hand peeling increases the cost of producing the bark.

Within the last 17 years there has been considerable practical experimentation in Canada and the United States on the application of chemicals to living trees to extend and fix easy peeling characteristics. A systematic study of the whole chemical debarking problem, sponsored by industry, has been underway for the past several years at the State University of New York College of Forestry, Syracuse, New York (1).[2]

The results of these practical experiments at Syracuse and by private companies have shown such good promise that it is felt that chemical debarking techniques will be adopted by a number of firms producing pulpwood. The chemical most commonly used at present in debarking treatments is a 40% solution of sodium arsenite.

The advantages of chemical debarking have been listed as follows (2): "The treatment of standing forest trees with sodium arsenite makes it possible . . . to produce pulpwood almost the year around. Instead of felling and then peeling with axe and spud 2 or 3 cords per day, one man can girdle and treat 10 to 20 cords per day during the sap-peeling season from mid-May until late July. The sodium arsenite kills the tree and after three or four months causes the bark to loosen . . . Treated trees can be felled, yarded and barked up when farm labor is not busy with regular farm work . . . Even in times of poor demand, many pulpwood companies will buy peeled wood when they will not buy rough wood." Other advantages depend upon the fact that the owner or forester can select at the time of the treatment the trees that should be cut.

The same author lists the disadvantages as follows: "Sodium arsenite is poisonous and care must be used in handling it. Wood treated in 1954 cannot be harvested as peeled wood until late fall or the spring of 1955. Not all pulpwood companies buy peeled wood. Sodium arsenite does not guarantee 100% peeled wood. Hand peeling will often be required."

A possible disadvantage not listed above is the effect of the treatment upon the tannin of oak or hemlock barks when used for the production of tanning extracts. Preliminary analyses of barks from treated and untreated trees were made to determine this point.

[1] A contributed paper.

[2] Numbers in parentheses refer to literature cited.

The Authors: J. S. Rogers, formerly head of Hides, Tanning Materials, and Leather Section at Eastern Utilization Research Branch, retired in 1954 after 26 years' service. He received B.S. from Syracuse U., M.S. from U. of Illinois.

C. W. Beebe received B.S. from U. of California, is supervisor of Tanning Materials and Processes Unit at Eastern Utilization Research Branch. He has studied production of vegetable tannins, improvement of tanning processes, and conservation of hides and leather.

F. P. Luvisi holds B.A. and M.A. degrees from Clark U., is engaged in research on domestic tanning materials and improvement of tanning processes.

W. H. Koepp received A.B. from Northern Michigan College of Education, B.S. from U. of Michigan. He was previously associated with Ford Motor Co., Cleveland-Cliffs Oron Co., Lend Lease and Foreign Economic Administrations, North Africa Joint Economic Mission, and French Supply Council. An associate professor, Koepp is studying chemical utilization of Michigan woods.

Experimental Procedure

Samples of bark were obtained from treated and untreated oak trees which were fairly comparable. The bark from the untreated trees had a tannin content of 12.4% and that from the treated trees had 7.9% tannin. This was strong evidence of tannin destruction, but it was not conclusive because the tannin content of the treated bark before treatment was not known. Further, assuming that the loss was as indicated, it could not be determined whether the loss was caused by girdling alone or was caused by the arsenic treatment.

To determine these points, a collaborative experiment was carried out between the Forest Products Research Division of the Michigan College of Mining and Technology, and the Hides, Tanning Materials and Leather Section of the Eastern Utilization Research Branch of the U. S. Department of Agriculture.

Results

On July 2, 1953, with the aid of two timber cruisers employed by the Marathon Corporation, 20 hemlock trees were chosen in the test area (Point Abbaye, Baraga County, Michigan) ranging in diameter at breast height from 14 inches to 22 inches (average d.b.h.—17 inches). Each tree was girdled with an axe, the bottom of the girdle being an average of 3.3 feet above the ground. The girdles averaged 6-½ inches in width. The bark from each girdle was carefully collected and bagged. A number was painted on each tree with white marking paint.

On the following morning, a 40% sodium arsenite solution was applied to the ten even-numbered trees. This solution labeled Atlas "A" sodium arsenite was purchased already prepared from the Chapman Chemical Company (Boundbrook, New Jersey).[3] This solution contains 4 pounds of arsenic trioxide per gallon.

As can be seen in Figure 1, the solution is carried in a portable knapsack tank to which air pressure is applied by a pump (about 2 pounds pressure was used) forcing the liquid through the spray hose into the handle of the brush. A spring valve in the hose releases as much solution as desired. Considerable care is given to be sure the girdled section is fully covered by the solution, particularly the upper edge. From the experience of the Marathon Corporation, one gallon of solution is required for every 20 cords of pulpwood treated.

The bark samples were spread on screen bottomed trays especially built for this purpose and stacked to dry outside the Forest Products Research Division building at Houghton, Michigan, under a lean-to shelter to prevent rain from leaching tannin from the bark. By August 1 the moisture content of several samples averaged 16.9 per cent on a dry basis. Within two weeks all samples were weighed and shipped to the Eastern Regional Research Laboratory for tannin analysis.

Inspection of the test plot on August 21, 1953, showed that five of the trees that had been treated were dead and on the remaining five few green needles remained.

[3] In furnishing the name of the company mentioned, it is understood that the U. S. Department of Agriculture does not in any way guarantee their product, nor is it recommended in preference to others not mentioned.

Table 1.—EFFECT OF GIRDLING ONLY AND GIRDLING PLUS TREATMENT WITH SODIUM ARSENITE

Tree No.	Sol. Extractives %		Non-Tannin %		Tannin %		Purity = Tan/Sol. Ext. x 100	
	1st Girdling	After 1 Year	1st Girdling	After 1 Year	1st Girdling	After 1 Year	1st Girdling	After 1 Year
	TREES GIRDLED ONLY AT BREAST HEIGHT							
			A′	B′	A	B		
1	25.09	26.54	8.75	9.88	16.34	16.66	65.13	62.77
3	22.03	25.30	8.20	9.44	13.83	15.86	62.78	62.69
5	23.57	23.03	8.63	8.34	14.94	14.69	63.38	63.79
7	23.14	25.26	8.38	9.30	14.76	15.96	63.79	63.18
9	24.33	26.71	8.56	9.65	15.77	17.06	64.82	63.87
11	24.93	26.69	8.52	9.73	16.41	16.96	65.82	63.54
13	25.31	27.56	9.52	10.22	15.79	17.34	62.39	62.92
15	25.49	27.52	9.22	9.70	16.27	17.82	63.83	64.75
17	24.66	26.22	9.69	10.16	14.97	16.06	60.71	61.25
19	27.63	30.21	9.98	9.85	17.65	20.36	63.88	67.39
Avg.	24.62	26.50	8.95	9.63	15.67	16.87	63.65	63.62
	TREES GIRDLED AND TREATED WITH SODIUM ARSENITE							
			C′	D′	C	D		
2	26.43	20.65	8.34	6.24	18.09	14.41	68.44	69.78
4	24.43	18.33	8.51	5.47	15.92	12.86	65.17	70.16
6	26.21	17.34	9.93	5.70	16.28	11.64	62.11	67.13
8	28.13	20.67	9.79	6.17	18.34	14.50	65.20	74.14
10	29.60	21.32	10.33	6.67	19.27	14.65	65.10	68.71
12	27.41	16.97	9.98	5.88	17.43	11.09	63.59	65.35
14	27.05	18.45	9.68	5.56	17.37	12.89	64.21	69.86
16	26.62	19.39	9.99	5.94	16.63	13.45	62.47	69.37
18	20.79	14.72	8.25	4.93	12.54	9.79	60.32	66.51
20	18.79	14.33	6.85	4.41	11.94	9.92	63.54	69.23
Avg.	25.54	18.22	9.16	5.70	16.38	12.52	64.02	68.62

Fig. 1.—Method of applying the arsenite solution.

Table 2.—EFFECT OF GIRDLING AND TREATMENT ON BARK 20 FEET ABOVE GIRDLING POINTS*

Tree No.	Soluble Extractive %	Non-Tannin %	Tannin %	Purity = Tan/Sol. Ext. x 100
	TREES GIRDLED ONLY			
		E′	E	
1	23.63	10.47	13.16	55.69
3	20.40	8.89	11.51	56.42
5	20.80	7.86	12.94	62.21
7	21.38	8.51	12.87	60.20
9	23.65	9.85	13.80	58.35
11	25.56	11.90	13 66	53.44
13	23.02	9.47	13.55	58.86
15	24.78	9.90	14.88	60.05
17	26.03	12.28	13.75	52.82
19	28.89	12.27	16.62	57.53
Avg.	23.81	10.14	13.67	57.56
	TREES GIRDLED AND TREATED WITH SODIUM ARSENITE			
		F′	F	
2	15.92	6.77	9.15	57.49
4	14.07	4.88	9.19	65.32
6	15.54	6.19	9.35	60.17
8	17.71	6.22	11.49	64.88
10	17.99	6.11	11.88	66.04
12	14.87	5.93	8.94	60.12
14	15.05	5.64	9.41	62.52
16	17.11	5.96	11.15	65.17
18	13.49	5.31	8.18	60.64
20	14.81	4.56	10.25	69.21
Avg.	15.66	5.76	9.90	63.16

*Trees were sampled only at end of test.

It has been determined that best results can be obtained on treated trees by allowing them to stand over winter before harvesting. The alternate freezing and thawing and swaying of the trees helps to loosen much of the bark. Thus, in the case of this experiment, it was decided to allow one year to elapse before taking additional bark samples.

The Marathon Corporation had retained a logging jobber to cut their pulpwood on Point Abbaye and they arranged with him to have our 20 test trees cut down on July 8, 1954. One of the authors was present when the hemlock was cut down and supervised the taking of additional samples from each tree. The first sample in each case was another girdle section of bark immediately above that removed on July 2, 1953. These sections were about 9 inches in width. The second sample from each tree was obtained 20 feet up the trunk from the top edge of the lower girdle just removed. A larger width of girdle was taken here, averaging about 15 inches.

Every sample taken from the treated trees came off the trunk very easily. Those from the girdled but untreated trees came off less readily, and in the case of No. 5 tree the bark was very tight and difficult to peel.

All of the bark samples were again carefully collected and dried on screens as was done a year previously. When weighed and shipped to the Eastern Regional Research Laboratory, the moisture content on three samples averaged 17.69 per cent.

All bark samples were analyzed at the laboratory by the official methods of the American Leather Chemists Association (3). The results of these analyses are shown in Tables 1 and 2 and a summary and analysis of the results in Table 3 (4).

Discussion

It will be seen from Table 1 that in every case where a tree was girdled and treated with sodium arsenite, there has been an appreciable loss of tannin. As shown in Table 3, this loss was 30.97 ± 7.88% of the tannin in the bark originally. There was a loss of 45.47 ± 8.37% of the non-tannin. This disproportionate loss of non-tannin as compared with tannin has raised the purity of the bark.

Table 2 shows that there has been a large loss of tannin in the bark 20 feet above the girdling point on trees treated with the arsenite. The trees were not sampled at this point originally and therefore the exact loss of tannin cannot be determined. If we asume that the average difference in per cent tannin between breast height and 20 feet was similar for the two lots of 10 trees at the beginning of the experiment, Table 3 indicates a loss of 25.80 ± 10.42% of the tannin at the 20-foot height due to the use of sodium arsenite. This is of the same order of magnitude as the loss at the girdling point.

Where the trees were girdled only and not treated, there has been an increase in tannin in every case but one, as shown in Table 1. As shown in Table 3 this increase is significant and amounts to 7.66 ± 3.75% of the tannin. This may be caused by an increase in tannin content during the year. It might also be caused by leaching of the bark during rain storms, and the accumulation of soluble matter near the base where the sample was taken. If this same leaching and deposition of tannin also took place in the treated trees, the tannin content of these samples at the end of the test would also be higher in the same proportion. Therefore, the loss of tannin would actually be somewhat higher than that shown in Table 1. However this is of only minor importance.

The arsenic contents of the bark samples from the treated trees were breast height–15 to 40 parts arsenic per million parts of bark; 20 foot height—2 to 3 p.p.m. It seems highly unlikely that the chemical effects of this amount of arsenic on tannin would be significant. We must probably look elsewhere for the cause of the destruction. However, it would seem desirable to determine the effects of other materials proposed for debarking, such as sodium monochloracetate, chloracetaldehyde, or ammonium sulfamate. It would also be desirable to investigate other factors, such as concentration of solution, and length of time between application and felling.

Table 3.—ANALYSIS OF RESULTS*

Columns Compared	Variables	$\bar{X}_1$	$\bar{X}_2$	S_1	S_2	t*
A vs B	Tannin with time (one year)	15.67	16.87	1.082	1.514	2.04
C vs D	Tannin with time + sodium arsenite	16.38	12.52	2.403	1.831	4.04
B vs E	Tannin with height† (20 feet)	16.87	13.67	1.514	1.346	4.99
D vs F	Tannin with height‡ (20 feet)	12.52	9.90	1.831	1.230	3.75
$\frac{A-B}{A}$ vs $\frac{C-D}{C}$	Tannin with sodium arsenite	7.66%	23.31%	5.246%	5.70%	12.61
$\frac{A-E}{A}$ vs $\frac{C-F}{C}$	Tannin with sodium arsenite (20 ft.)	12.84	+38.64	4.300	10.256	§
$\frac{A'-B'}{A'}$ vs $\frac{C'-D'}{C'}$	Non-tannin with sodium arsenite	7.87%	37.60%	6.4800%	5.208%	18.87

95% Confidence Units—Net Loss due to Sodium Arsenite

$\left.\begin{array}{l}\frac{A-B}{A}\text{ (Tannin) } \pm 3.75\% \\ \frac{C-D}{C}\text{ (Tannin) } \pm 4.13\%\end{array}\right\}$ $(-7.66 \pm 3.75\%) - (+23.31 \pm 4.13\%) = -30.97 \pm 7.88\%$

$\left.\begin{array}{l}\frac{A'-B'}{A'}\text{ (Non-tannin) } \pm 4.84\% \\ \frac{C'-D'}{C'}\text{ (Non-tannin) } \pm 3.73\%\end{array}\right\}$ $(-7.87 \pm 4.64\%) - (37.60 \pm 3.73\%) = -45.47 \pm 8.37\%$

$\left.\begin{array}{l}\frac{A-E}{A}\text{ (Tannin—20 ft.) } 12.84 \pm 3.08 \\ \frac{C-F}{C}\text{ (Tannin—20 ft.) } 38.64 \pm 7.34\end{array}\right\}$ $(+12.84 \pm 3.08) - (38.64 \pm 7.34\%) = 25.80 \pm 10.42\%$

*Critical I 0.01 = 2.878.
†Untreated trees—one year after girdling.
‡Arsenite treated trees—one year after girdling.
§t value invalid because F value is critical.
The assumption was made that the average difference in per cent tannin between breast height and 20 feet was similar for the two lots of 10 trees at the beginning of the experiment.

Conclusions

The use of sodium arsenite as a chemical debarking agent for hemlock trees causes a loss of about 30% of the tannin in the bark. The effect is not localized but is distributed throughout the height of the tree. There is a need to investigate other debarking chemicals and methods of application.

Acknowledgment

We acknowledge with thanks the aid of the Marathon Corporation in procuring the samples, of Mrs. M. I. Happich in making the analyses, and of C. L. Ogg in making the statistical analysis.

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Technical Training Through Short Courses[1]

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Summary is made of data secured from forestry colleges and other institutions that gave short courses during the past five years, and lists their plans for the next five years. The author discusses the success of these courses from personal observations and predicts future needs for such training.

A NEW TREND IN MODERN EDUCATION is to popular short courses offered throughout the nation to teach any subject from baby sitting to atomic radiation techniques. Is the field of forestry being adequately represented in this educational trend?

A questionnaire survey was made of the 36 forestry schools in the United States and 4 wood laboratories to determine the number and type of technical short courses that have been given during the past five years, including information on the attendance, cost, etc., together with an estimate of the courses to be given in the next five years. Replies were received from all but one institution and, as usual with questionnaire data, there were some gaps in the information available, making it necessary to give a general interpretation of some of the data.

Two-thirds of all forestry schools have conducted short courses in 23 different subjects during the past five years; this amounted to a total of 163 courses given to approximately 5,400 students. In addition, four laboratories conducted 48 courses in five different subjects to about 800 persons during the same period. Thus, 211 courses have been given to 6,200 persons during the past five years and 228 courses are expected to be given during the next five years. (Table 1).

It is interesting to note that 70 per cent of the reporting institutions have conducted short courses, and all but one of them plan to continue the short-course program. Several schools which are not now giving short courses have the matter under consideration and indicate a possibility of offering this type of instruction in the future. Although the number of courses increased 79 per cent from 1950 to the present, the reports indicate an increase of only 8.1 per cent in short courses during the next five years. Many respondants pointed out the inadvisability of planning short courses more than one or two years in advance; thus the above figure is the result of only a partial estimate.

These short courses vary in length according to the subject matter being presented; courses such as sawmilling are often given as a 1-day field conference, whereas courses like lumber retailing, seasoning, and others may run from 2 to 4 weeks and offer much more intensive training. Approximately 40 per cent of the courses lasted from 1 to 4 days, 45 per cent between 5 to 8 days, and 15 per cent between 9 and 30 days. The 5-day short course was most popular and represented 16 per cent of all courses given.

The enrollment costs have a considerable range. One- to 4-day courses are often free or range up to $50, the 5 to 8-day courses cost from $5 to $125, and the 9-day and over courses cost from $30 to $200. It was not possible to establish a sound ratio betwen the length of the course and the cost, since the variation is more in the type of course than in its length. Most sawmill courses are given free or for a small registration cost, whereas seasoning courses, lumber retail courses, and photogrammetry courses cost the student in the neighborhood of $5 to $10 per day.

Enrollment statistics indicate that 23.6 per cent of the persons taking these short courses are forestry graduates, 16.5 per cent are college graduates trained in other fields, 50.9 per cent are high school graduates, and 9.0 per cent are men who did not complete high school training. Approximately 85 per cent of the men attending forestry short courses are employed and sent to the courses by industries, whereas 15 per cent are not employed by industry and are working for public agencies or for themselves.

The data given above do not include lumber and trade associations that have given courses in grading, merchandising, advertising, public relations, etc., nor do they include industry courses such as the well-known seasoning lectures given by John Devine of the Moore Dry Kiln Company, nor a large number of courses

Table 1.—SHORT COURSES GIVEN DURING THE PAST 5 YEARS AND PLANNED FOR THE NEXT 5 YEARS BY FORESTRY SCHOOLS AND LABORATORIES IN THE UNITED STATES

Type of short course	Length of course (days)	Data on courses given in past 5 years: No. of institutions	Data on courses given in past 5 years: No. times given	Data on courses given in past 5 years: Attendance reported*	Plans for next 5 years: No. of institutions	Plans for next 5 years: No. times to be given
1. Sawmilling	1- 7	11	24	1125	11	22
2. Lumber grading	2- 5	10	27	458	9	24
3. Photogrammetry	5-10	10	21	418	8	22
4. Seasoning	2-10	7	27	604	8	30
5. Gluing	1- 5	6	31	368	4	16
6. Lumber retailing	28-30	5	25	878	5	24
7. Forest management	2-30	5	14	362	7	26
8. Forest soils	1-15	3	6	89	2	2
9. Forest mensuration	5	2	2	59	2	2
10. Wood preservation	1- 3	3	3	55	1	2
11. Wood finishing	5	2	6	156	2	6
12. Quality control	3- 5	2	4	59	3	12
13. Log and tree grades	3	3	4	135	0	0
14. Building material and marketing	10	1	3	61	1	5
15. Trouble shooting in woodworking	5	1	3	41	1	5
16. Logging engineering	5	1	2	153	1	2
17. Road location	6-10	1	2	32	1	1
18. Furniture manufacturing	15	1	1	23	1	5
19. Wildlife management	4	1	1	10	1	5
20. Farm woodlot forestry	2	1	1	30	1	2
21. Forest genetics	5	1	1	51	1	1
22. Forest insects and diseases	5	1	1	30	1	1
23. Naval stores	2	1	1	35	1	1
24. Soil conservation	6	1	1	-	0	0
25. New courses†	1-10	0	0	0	4	12
Total			211	5232		228

*Attendance was reported for 84 per cent of the courses given. Estimated total is 6,200.

†New courses to be given are: Industrial Foresters Seminar—10 days; Carbide Tools—5 days; Writing for Foresters—2 days; Power Saws—1 day.

[1] Presented at Session VIII, Education, Ninth National Meeting, FPRS, June 21-24, 1955, in Seattle, Wash.

The Author: Walton R. Smith received B.S. from N. C. State College and was associated with U. S. Forest Products Laboratory and Walton Lumber Co. before appointment to present position. He has served as Trustee and Chairman of Carolinas-Chesapeake Section of FPRS and is Arrangements Chairman for the 10th National Meeting to be held June 4-7, 1956, in Asheville, N. C.

given by the Forestry Division of the Tennessee Valley Authority. Information from the Tennessee Valley Authority indicates that during the past 5 years they gave 37 one-day sawmill courses to about 3,000 people, six hardwood tree quality-index seminars to approximately 175 foresters, two pine thinning courses to 59 foresters, and one woodworkers' conference to about 120 persons engaged in small craft shops.

The Forest Products Laboratory has given six different courses during the past five years, sponsored and paid for by the military or industry. Over 500 persons were sent to these courses, which were not open to the public at large. Subjects covered were packaging, lumber inspection, and merchandising. Data on these courses are not included in this report.

There are undoubtedly other agencies or other schools giving forestry short courses that were not available for this report.

The question frequently arises concerning the value of short courses to the students enrolled, and to the school. It is the author's opinion, after participating in a number of such short courses at various schools, that the students receive excellent information in special technical fields as well as considerable inspiration to do a better job. Furniture manufacturers have stated that seasoning courses given to their kiln operators have saved them thousands of dollars each year. In fact several have sent their kiln operators to the same course for a second time. Many short-course students return year after year to study new subjects, thus testifying to the value of the instruction.

Research Improved

The school, in turn, has an opportunity to come face to face with problems encountered by foresters and employees of wood-using industries. Concern has been expressed by some that the amount of time consumed in conducting short courses cuts into the amount of research that can be accomplished. Here, it is the author's opinion that the quality of research conducted is actually greatly improved by association with forestry problems, and it appears that the schools conducting the heaviest programs in short courses are also producing some of the best research results. Research problems in seasoning, gluing, machining, and forest management frequently stem from industrial problems presented by short-course students.

It is obvious from Table 1 that most short courses being offered by forestry schools are in the field of wood utilization. As would be expected, the schools offering a curriculum in wood utilization are the ones conducting the major portion of short courses. The opportunities for expansion in short-course training are undoubtedly great in the field of utilization and management and will be supported more and more by industry.

The short-course type of training is not new, but its worth has been proven during the recent war period when it became necessary to give rapid technical training to men who lacked formalized education. It has proven to be a good tool and is widely used by all classes of industry. It can and should be more widely used in the field of forestry and wood utilization, not as a substitute for professional training, but as a refresher course for men who have had formalized training, and for vocational training for men in industry. Forestry schools, laboratories, and other agencies can perform a real service by making this type of training available.

Discussion

P. H. W. Creden (Edward Hines Lumber Co.): In courses such as you describe, do you endeavor to have those in attendance housed in one place where they can be together outside the formal sessions, have "bull sessions" and discussions on problems of mutual interest?

Mr. Smith: Our most successful courses have been those in camps, on college campuses, or in small communities away from other influences. It's always best to keep the students living together as a group since a lot comes out of the informal bull sessions, as you call them. We also try to have one or two evening sessions and a banquet.

Everett Ellis (U. of Idaho): In the short courses in which you have participated, have you found any changes in trends of sponsorship; that is, are they the results of the efforts of a single agency, or is there a trend to the combined cooperative effort of schools, federal agencies, and perhaps industry?

Mr. Smith: Shortly after World War II, the Forest Utilization Service started a number of kiln drying courses with the help of the U. S. Forest Products Laboratory. In the Southeast, we worked with the Southern Furniture Manufacturers Association. Other courses were given in gluing and sawmilling in cooperation with industry. The forestry schools and extension foresters soon became interested in the short courses and as rapidly as possible we urged them to take over the organization and sponsorship with federal personnel helping as instructors. Today the sponsorship is largely by colleges and industry and we feel that is the best way.

Mr. Ellis: Are these courses self-generating; do they grow and continue to develop?

Mr. Smith: Yes, returnees indicate this to be true. There appears to be a great deal of interest in this sort of thing and through the years there appears to have been no slackening of this interest.

Fred C. Simmons (Northeastern Forest Experiment Station): I seriously question if colleges are the institutions that should be giving many of these short courses. Some, like those in quality control and perhaps kiln drying, are definitely of college caliber. Others, such as saw filing and small sawmill operation, are more nearly at the vocational level, and in my opinion should be sponsored by and given at vocational schools rather than colleges. Vocational training is an art and science in itself, in which college professors are rarely equipped to do a creditable job. Also, such vocational training should often be given for longer periods than the ordinary short course. Let's not kid ourselves that we are meeting the need by a superficial one- or two-week course, when four to six months, or even longer, is required to do a creditable job. The National Hardwood Association course in lumber grading at Memphis is an example of what I mean. Another is a six-month course in band saw maintenance we are currently organizing in cooperation with the Williamsport, Pa., Institute of Technology.

E. S. Feldman (Furniture Manufacturers Assoc. of Southern Calif.): A number of short courses with which I am familiar have used men from industry as instructors. We have instituted a number of such courses at U.C.L.A., in the Engineering Extension Division. These courses are frequently under the direction of one person from the furniture manufacturing industry who may call in other industry experts to lecture on their own specialties. This is good because it gives the trainees an industrial slant.

Mr. Creden: Who should give these courses, university professors or qualified industrial men?

Mr. Smith: We use men from industry whenever possible. We also use forums for discussion of problems that are brought out during the sessions and these are frequently led by industrial personnel.

Integrated Utilization of Northeastern Timber Stands[1]

L. F. WHITTEMORE and C. S. HERR

President and Chairman of the Board; and Vice-President in Charge of Woods Operations, Brown Co., Berlin, N. H.

Integrated utilization begins in the woods, with each tree cut according to its best end use. This paper describes how a Northeast firm integrated its operations, with No. 1 common or better sawed into lumber and lower grades, slabs, and edgings chipped for pulp. Timing of logging operations must be planned carefully, to avoid decay losses and provide deliveries consistent with mill usage.

THE INTEGRATED USE of northern hardwoods on a large scale is a relatively new field with Brown Company and other industries of New England. The main product now being selected in our cutting operations is the sawlog. Hardwood log production is new to us, but our firm is no stranger in the lumber business.

Even since the earliest days of logging in northern New England, the axe and the cross-cut saw were in continuous use felling the virgin red spruce and eastern white pine along the upper reaches of the Androscoggin River to feed the huge sawmills of the Berlin Mills Company located at Berlin, N. H. These mills rose to a peak production of about 55 million board feet per year to become the largest enterprise of its kind east of the Lake States. Although the mills twice suffered disastrous fires, they continued to produce regular substantial volumes of softwood lumber until 1930. The Brown Company, which had grown out of the Berlin Mills Company, by this time had become one of the nation's leading pulp and paper producers, and the manufacture of lumber was discontinued.

During World War II, a new demand developed for New England hardwood lumber and veneers, principally for yellow birch and sugar maple. In 1950 Brown Company, with new management and new ideas, was the first to decide that here in the Northeast was an opportunity for real integration since pulp and lumber production could live together to the mutual advantage of both. Stumpage sales of high grade hardwoods were discontinued on company lands and a new program was put into effect whereby hardwood logs suitable for veneer use were separated from pulpwood in the woods operation. These logs were sold to existing veneer mills in Maine and Vermont for an economic return far greater than they would have yielded in pulp use.

Operations Integrated

In 1952 when forest inventories had been reviewed and logging plans developed, a new hardwood sawmill was built in Berlin, and the company was back in the lumber business, but this time as an integral part of the pulp and paper operation. The production was now under an entirely different set of conditions. The emphasis was placed on quality with those grades commonly known as the "non-profit" grades finding their way into chips for the manufacture of pulp and paper.

The production of the mill for this first year was taken by one of the largest furniture manufacturers in the East who leased the mill. Being large users of short length lumber, the logs were cut in 8-foot lengths and the lumber produced ran from 4 to 8 feet. In 1954 Brown Company took over the production of the mill, doubled the capacity, and started manufacturing hardwood lumber in the conventional 4- to 16-foot lengths. The woods operations shifted from 8-foot to 10- to 16-foot logs.

The present objective of the mill is to saw only the lumber from logs which will grade No. 1 common or better according to National Hardwood Lumber Association rules. All other grades and the slabs and edgings are being chipped for pulp use. The quality of the hardwood log cut in the woods is carefully controlled so that recent mill production figures from these logs show that only about 2.5 cords (85 cu. ft. = 1 cord) are needed to produce 1,000 board feet of this high quality lumber, plus about 1.5 cords-equivalent of chips.

At this level of integration, about 14 per cent of all northern hardwoods cut by the company is being utilized for sawlog material. This is largely yellow birch because the hardwood stands in the area run heavy to this species.

The new hardwood sawmill today has a production capacity of approxi-

Chips from slabs and edgings being conveyed to car for transportation to pulp mill.

[1] Presented at Session III, Logging and Milling, Ninth National Meeting, FPRS, June 21–24, 1955, in Seattle, Wash.

The Authors: Laurence F. Whittemore holds honorary degrees from Dartmouth College, U. of New Hampshire, New England College, Lowell Technological Institute, Marlboro College, and Suffolk U. He was employed by the Boston and Maine Railroad and State of New Hampshire from 1913–46. From 1946–48, he was president of the Federal Reserve Bank of Boston; 1948–50, president of the New York, New Haven, and Hartford Railroad. In 1950 he became president of Brown Co., Berlin, N. H., and Brown Corp., LaTuque, Quebec; in 1952 named Chairman of the Board, Brown Co.

C. S. Herr received a B.S. degree from Pennsylvania State College and M.S. from Harvard U. He served with the U. S. Forest Service, U. of New Hampshire Extension Service, and wood units of O. P. A. and W. P. B. before joining Brown Co. in 1943 as chief forester. He was named assistant resident woods manager in 1945, resident woods manager in 1950, and vice-president, woods operations, in

mately 8 million board feet annually of this high grade lumber. The mill itself is a Prescott mill throughout and consists of two 8-foot band saws and two 5-foot horizontal resaws. There are two shotgun-driven carriages, air operated, capable of handling the largest hardwood logs of New England in 16-foot lengths. All lumber is trimmed by an electrically controlled dropsaw trimmer. Edgers, resaws, trimmers, and conveyors are powered by electricity. Conveyor chains and belts carry the cores and other sawing wastes from the tail of the mill to two Carthage 40-inch disc chippers.

Softwood Operations Integrated

Although this paper is concerned with hardwood integration, it would not be complete without mention of the softwood logging and utilization program. While the hardwood mill was taking shape, the spirit of integration in the woods turned to softwood logs and once again the old growth spruce and pine hit the white water in the spring in 16-foot lengths rather than as the usual 4-foot pulpwood. A circular mill in Berlin was put into production of softwood lumber, and three new mills were constructed in 1954. The total rated capacity of these four mills is now about 12 million board feet annually.

In these mills the pine is sawn for grade and most of the spruce goes into dimensional timbers for building and construction use. Here again the slabs and edgings and poorest grades of lumber are chipped for use in pulp and paper production. In total the lumber production phase of the Berlin operation has provided new employment for more than 100 men.

What did all this mean in the woods? It meant a complete transition in the company's woods operations which perhaps could be best described by the two words "planning" and "training." No longer could 800 wood-cutters be turned loose with chain saws and horses to cut everything into 4-foot bolts. Now the cutter had to be made familiar with what constitutes a good sawlog. He had to become familiar with many new terms such as sweep, butt rot, interspersed rot, seams, ring shake, doze, heartwood, sapwood, stain, etc. He had to understand also the philosophy behind the integrated program—that cutting the tree into its best end use would eventually make his own job more secure and stable. Many of these woodsmen did not understand English and had to be taught and trained by use of visual material such as charts and colored slides.

Although the horse still plays an important part in the yarding of pulpwood and logs in the firm's woods operations, the matter of road spacing, terrain, and the size of the timber becomes much more important to the foreman in laying out his operation. Yards for pulpwood, hardwood and softwood logs, had to be swamped or cleared and planned to accommodate all separations so that the wood might be hauled, each kind according to a scheduled delivery.

Woods supervisory personnel such as foremen, straw bosses, and scalers had to become log graders and teachers. The fact that this program has succeeded so well is a tribute to these men in the woods who have made it work.

The time element of cut became all important, especially in the case of hardwood logs. It was found that hardwood logs cut in the spring and summer months had to be moved for immediate use at the mill before they became spoiled by stain fungi, a situation that can develop in relatively few days during the warmest and most humid weather. It also became necessary to carry on certain "hot-logging" operations to keep the mills turning out lumber on a year-round basis. In such instances, tractor logging of tree length logs was used far more than ever before.

Logging Problems

Each tractor operation seemed to present its own specific problems, and various combinations of bunching tractors and main line tractors were used. The D–4 Caterpillar with high speed winch proved advantageous on several operations as a pre-bunching unit. Sometimes teams were used in pre-bunching for main line tractors. The D–6 Caterpillar with a sulky became the accepted unit for the main line haul. New all-wheel drive rubber tired skidding equipment was developed in cooperation with Austin–Western Company, and this has also proven satisfactory in skidding tree length material to roadside landings.

On these operations, trained men were used to mark the tree length logs for cutting into the proper lengths at the landings for the best level of integration. In still other areas, where the moving of hardwood logs during the summer months was not considered economically sound because of ground conditions, trained men paint-marked the trees containing potential logs so that they could be left standing during the pulpwood cut, and relogged by tractors during the fall and winter.

During the peak production season of fall and winter, hardwood logs had to be placed in storage piles and put under water sprays to keep them safe for summer sawing. This was accomplished quite successfully by a system employing electrically and gasoline driven pumps, aluminum pipe, and oscillating spray nozzles.

In still other areas where the composition of the stand contained large amounts of northern white pine, the smaller species such as spruce and hardwood were prelogged with horses and then relogged for pine by tractors. This, it will be noted, is a leaf taken from the book in the Pacific Northwest.

A large part of the volume of spruce and pine sawlogs is transported by truck to water landings 35 to 40 miles from Berlin. These logs are then driven to the mills in the spring, along with the softwood pulpwood. Here they are sorted according to their final use. Currently, in the pine operations the total merchantable portion of the tree is transported to the landings in log form and there is finally fitted into pulpwood or sawlogs according to its quality.

The transportation problem was also great in that a large percentage of this wood was cut in areas from 75 to 80 miles from the mills at Berlin. The company has swung over to the use of larger trucks and trailer hauling of logs and pulpwood. It was necessary to use larger mobile cranes for the handling of logs and packaged or sling handling of pulpwood. The transportation of wood to the mills in tree lengths is under consideration because, as has been found in the Northwest, it probably is the most satisfactory method of getting maximum integration.

Improving Methods

These methods and many others have been and are still being tried and improved upon so that a steady flow of softwood logs, hardwood logs, and pulpwood aggregating over 250,000 cords will reach the mills in the quality and quantities needed to make this a going operation. In this trial period, certain logging costs per unit have naturally been somewhat increased. However, as personnel become better trained and methods are gradually improved, the margin of profit on these items, with a higher economic value than pulpwood, may be expected to grow steadily larger. It is already known that the integrated use of Northeastern forests pays.

The logging problems are many and varied, but they are gradually being worked out by an able and alert woods organization. Many of the men in this organization are trained technical foresters and fully understand the theory and, by now, the practice of utiliza-

tion. In line with better utilization of the forests has come more mechanical logging equipment and a better type of forest worker. In step with this, the company has built modern camps and living quarters where the woods workers can enjoy most of the comforts of home.

Moreover, this integrated operation has its advantages in forest management as now only the mature stands containing appreciable sawlog volumes are being operated. Younger stands which might previously have been considered merchantable from a pulpwood standpoint are being left for future sawlog operations. In effect, this is silviculturally regarded as a group selection system.

The company is still in an exploratory stage in its integrated program. However, all indications at present point to the fact that woods operations must and will be planned so that the product of the forest will go into that use for which it is most suited economically. Thereby it will serve the interests of all those who are directly and indirectly affiliated with the utilization of our natural resources.

Diversified Products

Currently the forest lands of Brown Company are yielding the following products: group of pure wood fibre grades made for conversion into such articles as cellophane, photo prints, letterheads, boxed stationery, invitations, facial tissues, and butter wrappers; pure, fine cellulose powder used in the manufacture of cigaret filters, welding rod coating, rubber soles and heels, and molded plastics, also used in filter presses when filtering oils, alumina, caustic soda and many chemicals; both bleached and unbleached papers made for conversion into flour bags, gummed tapes, sandpaper, potato bags, carpet yarns, resin-treated

Hot pond at Brown Co., Berlin, N. H., with sawmill shown in background.

table tops, coffee bags, pressure-sensitive tapes; industrial and household paper towels and tissues; sewer pipe for sewage and drainage installations; and conduit for encasing electrical wires underground; a tough, leatherlike material used in the manufacture of shoe innersoles, wallets, belts, handbags, hat bands, and imitation leather; chemicals including chlorine, chloroform, and soda bleach; hardwood lumber, principally highest grades of yellow birch; and softwood lumber, including spruce for dimensional timbers and graded eastern white pine for finish work such as door casings, window frames, siding and many other uses where high quality lumber is desired.

This program of integrated utilization will bring new economic vigor to our company and the entire Northeastern region.

Discussion

F. C. Simmons (Northeastern Forest Experiment Station): I agree that everything should be cut log length and selection of logs and pulpwood made at the deck. One company in Virginia is bringing in mixed loads of logs and pulp—all log length. There isn't much excuse for 4- and 5-foot lengths any more since we do not depend on manpower to lift and transport each bolt six or more times between stump and mill.

Q. Are you cutting tops and limbs for pulpwood? What is the minimum top diameter?

Mr. Herr: Not in the present stands—only the main trunk. Four inches is the minimum for pulpwood, 10 inches for sawlogs.

Jack Pfeiffer (Oregon Forest Products Lab): Do you do any log grading in the woods? Do you have a clear-cut definition of lumber grade?

Mr. Herr: Yes, we have developed a log grading system of our own which provides a selected log.

Mr. Pfeiffer: Do you manufacture flooring and similar products?

Mr. Herr: No.

Mr. Pfeiffer: Do you have any overrun figures—in your band mill, for example?

Mr. Herr: Nothing significant.

The Effect of Hardboard, Particle Board, and Similar Products on Traditional Plywood Markets[1]

THEODORE SMETANA

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A competitive situation may exist in certain areas of use between plywood, hardboard, and particle board. Generally, however, this need not necessarily be true if the widely divergent characteristics of all three products are considered. The potential contributions of these new products to improved plywood techniques may well surpass in advantages gained for plywood any competitive situations that might occur in other areas.

THE EFFECT WHICH HARDBOARD, particle board, and similar new products will have on traditional plywood markets is a subject which has, no doubt, occurred at one time or another to virtually everyone interested in the manufacture, sale, or use of plywood. While the question may not permit any one all-conclusive answer, an examination of the existing basic factors may prove helpful in giving a clue as to what may reasonably be anticipated.

What is meant by the term "traditional plywood markets"? End-uses of plywood are so diverse that one is at a loss to enumerate specifically the multiple purposes for which this product serves so well. However, as a broad generalization plywood's main consumption is included within the following major classifications: home and building construction; furniture, fixture, and cabinet manufacture; transportation equipment; factory equipment and maintenance; and marine construction.

Advantages of Plywood

What are the characteristics of plywood which have resulted in such widespread acceptance of this product in these major categories, as well as in many other areas of use? Any tabulation of plywood's advantages would necessarily include the following qualities: superior strength versus weight ratio; ease of workability—in sawing, machining, gluing, nailing and screwing—without danger of edge splitting; compatibility for a wide variety of finishes; broad assortment of standard thicknesses and sizes; availability of special large sizes, such as scarfed panels; saving in time and labor in its use and installation; aesthetic value in the warm beauty of genuine wood grain and texture in a form convenient to use; an exterior glue bond impervious to moisture, where required; savings in redecorating and maintenance cost; and availability on a nationwide basis.

In view of the widely diversified end-uses which are served through plywood, it is inevitable that some portion of such a broad market will occasionally or even frequently utilize other competing types of materials. Roof decking is widely constructed of plywood, but it is also true that lumber and even other types of material are being employed for this purpose; likewise with sheathing, underlayment, wall interiors, fixtures, etc.

There may be some who "view with alarm" and are quick to foresee the doom of plywood every time a competing product is utilized where plywood might have served, but simple arithmetic should quickly dispel such thinking. The entire plywood industry could not possibly supply the requirements which would be needed to serve adequately every possible place where plywood might be used. The over-all growth of the market potential has been so rapid as to outstrip the productive capacity of any one type of product—whether plywood or competitive materials. Certainly, hardboard is not a new product on the market, yet despite its increasing use over many years the plywood demand has continued to grow to record proportions.

It is doubtless to be expected that with the advent of increasing production and of refinements in hardwood and particle board in this country, some of the end-uses formerly served by plywood will be challenged increasingly by these newer products which possess in varying degrees one or more of the desirable attributes of plywood. For the most part, however, it is believed the challenge to plywood will be predicated largely upon such economic inducement as their use may offer, subject always, of course, to the requirement that the product characteristics are suitable for the end-use contemplated.

An example is the case of the television manufacturing industry, which not long ago regarded a reduction in cabinet cost as an absolute essential for survival. In seeking this goal, plastic and metal cabinets were being increasingly adopted until it was ascertained that wood grained hardboard provided a product superior to either of these other two materials. In this instance, a market being lost by plywood, due to cost factors, was captured by hardboard—not necessarily from plywood, but from the other substitute materials being considered as a replacement for plywood.

Qualities of New Materials

Perhaps a definition of hardboard and particle board would be helpful to some in explaining the respective components and qualities of each.

Hardboard is a product of fine interlaced wood fibers compressed under heat and pressure, generally with a small percentage of resins added to supplement natural wood binders. Some processes, however, rely entirely on a natural bond.

The fibers are obtained by treating wood chips with heat and moisture until they become extremely pliable, whereupon the chips are separated into fine silky fibers by a mechanical device such as an Asplund defibrator or by means of steam guns. The fibers are then felted and compressed under heat and pressure for the proper cycle to produce the hardboard bond which distinguishes hardboard from paper and other wood pulp products. Hardboard is generally produced with greater compression than particle board and thereby provides strength factors in thinner thicknesses not attainable by particle board.

Particle board includes those panel

[1] Presented at Session IX, Veneer and Plywood, Ninth National Meeting, FPRS, June 21–24, 1955, in Seattle, Wash.

The Author: Theodore Smetana has been associated with the veneer and plywood industry for 25 years. He was employed in plywood sales by Chicago Mill & Lumber Co. and Nickey Bros. before joining Weyerhaeuser Sales Co. in 1949 as manager of the pine veneer division. In 1952 he was assigned to plywood promotion for fir and pine plywood mills.

or sheet materials (also termed chipcore, chipboard, sawdust board) whose major ingredient is particles of wood such as chips, shavings, and granules, in contrast to the longer individual fibers in hardboard. These particles are not initially subjected to heat, moisture, and fiber masceration as in the case of hardboard. However, a substantially greater relative percentage of resins are required in particle board as the prime bonding agent.

The particle board is then formed and pressed under heat and pressure to the desired density and cured under controlled temperature and humidity conditions. Such particle board may vary considerably in composition and physical characteristics, depending upon the process of manufacture, particle size, and the density desired.

Broadly speaking, particle board is produced in three categories: high density (approximately 60# pcf); intermediate (approximately 40# pcf); and low density (approximately 30# pcf). Of these three types, the high density possesses the best stability and machining characteristics. The intermediate density, while not machining to as sharp an edge nor possessing as high a degree of moisture resistance as the high density, is generally regarded as adequate in these characteristics for most core stock uses. The low density particle board has been used in door construction and as an insulation board.

Particle board is considered to be dimensionally more stable than hardboard of the same thickness, and it customarily possesses better screw and nail holding powers than hardboard, even of the same density.

Uses of Particle Board

Particle board has been widely used in Europe, particularly in Germany, and is now arousing considerable interest in this country as a product which may make a major contribution toward reducing costs. This holds unusual promise with respect to its possibilities as a replacement for lumber core in plywood manufacture. The absence of the numerous glue joints inherent in conventional lumber core manufacture will not only reduce costs through the use of particle board cores but it will also avoid the hazard of sunken joints or joints "photographing" through the face veneer.

Several concerns are already utilizing particle board for core stock, many of them being outstanding leaders in furniture manufacture who have been so impressed with the possibilities of particle board that they have installed their own manufacturing equipment to produce their particle board requirements. It is reasonable to believe that an increasing rate of consumption in this field will inevitably follow as more and more manufacturers learn of the advantages of particle board in their own production.

For thick core use, particle board appears economically more feasible than hardboard as the particle board can be formed to produce heavy thicknesses in one operation. In contrast, as a result of the great resistance to heat transmission by the hardboard fibers, when pressed in thicknesses exceeding approximately ¼", a prohibitive press cycle is involved in "one-shot" forming of hardboard in the heavier thicknesses. Where thinner sheets of hardboard are laminated to attain the desired heavier thicknesses, an additional cost factor is injected which is not encountered in particle board manufacture.

The utilization by the plywod manufacturer of a uniformly defect-free and joint-free particle board as a core for his product may permit him to produce a superior panel for less money and in this maner re-establish his product in markets lost to other materials or gain markets heretofore unobtainable. Wall paneling is a market for which plywood is ideally suited and its present volume for this use could likely be considerably expanded through the development of techniques permitting wall sections fabricated with particle board cores faced with veneers on both sides.

Combination Materials

The plywood industry will continue to be alert in developing all of the possibilities which may exist in the combination of veneers with hardboard and particle board in order to achieve a product which may provide qualities superior to those possessed individually. Examples of such combinations are already in evidence in hardboard-clad plywood now being produced and increasingly utilized where the smooth, abrasive resistant qualities of hardboard coupled with the strength and light weight of plywood are important. As concrete forms, this product permits a considerably increased number of re-uses for the large project builder. Fixture, cabinet, counter, and shelving applications have also found this combination of hardboard and plywood advantageous.

In the manufacture of furniture, cabinets, and fixtures, particle board cores faced with veneer or plastic laminates are steadily gaining recognition as a technique producing a superior product with outstanding cost advantages.

Hardboard employed as a crossband under thin veneer faces is being widely adopted by the furniture and cabinet manufacturer as the numerous advantages of this material for such use have become more generally known. The availability of one piece stock in large sizes minimizes expensive edge gluing encountered with veneer crossbanding. Hardboard's complete freedom from undesirable characteristics common to veneer crossbanding such as twisty grain, knots and knot holes, splits, checks, rough or non-uniform cutting, has made a favorable impression wherever hardboard has been used for this purpose, and consumption in this field would indicate a material expansion.

The plywood industry regards present traditional plywood markets as primarily a foundation upon which to build constantly expanding markets for the future, incorporating new techniques and products in the manufacturing process where desirable, competing with them where necessary. Meanwhile, the industry will strive constantly for product improvement to better serve current uses and to successfully meet the requirements of new uses.

With the long-range outlook of an increasing demand as this country continues its phenomenal growth, the industry recognizes the important contribution which new products will provide in implementing the availability of materials in sufficient volume to meet the expanding requirements of our economy.

With such a forward-looking constructive attitude, the effect of these newer products must inevitably contribute to the continued growth and advancement of the plywood and allied wood industries, and the sustained progress of our country.

Discussion

F. F. Wangaard (Yale U.): Are there problems of a particle board core telegraphing through veneer faces, similar to that when a solid core is used?

Mr. Smetana: Telegraphing is less of a problem with particle board core because a one-piece core is used.

E. Reichman (Simpson Logging Co.): Does expansion of chipboard core, due to moisture change, have a tendency to split open a single face ply of veneer overlay?

Arnold Luhning (Western Nu-Ply Corp.): Not under ordinary conditions, because the linear expansion of veneers perpendicular to the grain direction is bigger than the linear expansion of a good chipboard core. Frequent moisture changes under extreme conditions may result in checking of the veneer surface as in any plywood.

Plastic Overlays for Wood Products[1]

W. R. WORKS

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Reports recent progress in the field of paper overlays and indicates the direction of probable future development. Paper overlays impart properties of appearance, protection of core, finishability, and increasing strength and stiffness, to plywood, lumber, single veneers, and hardboards.

PAPER LAMINATED to the surface of a wood product is called an overlay. The products most commonly overlaid at present are plywood and single veneers. Overlays and overlaying techniques now under development will bring about commercial applications in the near future in the fields of hardboard, particle board, and lumber.

The use of paper as a surfacing material for other wood products is a natural development. Paper is itself a wood product. It is made from cellulose fibers obtained from wood. Consequently, when paper is laminated to the surface of another wood product, it is a natural teammate. A paper surface is a purified wood surface.

Most of the applications for paper from its invention to date have been as a surface, so paper is an old hand at meeting requirements for surfaces. It is by nature strong, uniform in structure, even in color, and inexpensive. It lends itself to machine production methods because of its uniformity and because of its availability in roll or sheet form in almost any desirable size.

Wallpapers have beautified the interiors of our homes for years. In the form of gypsum board, gypsum lath, and building papers, important structural jobs have been performed by paper. During the past few years experimentation with synthetic resins has led to the development of truly durable papers. The combination of synthetic resins with paper has given paper a new property—weather-ability. Resin—impregnated paper overlays are now protecting plywood, lumber, and hardboards from the ravages of weather.

[1] Presented at meeting of Northern California Section, FPRS, May 13, 1955, in San Francisco, Calif.

The Author: W. R. Works holds B.S. degree in chemical engineering from U. of Washington. He was employed for four years with Central Research Dept. of Crown Zellerbach Corp. in product and process development, for past two years has been in New Products Sales Dept., with main interest in field of plastic overlays.

Objectives of Overlays

Since an overlay is a surface, it affects those properties of the material it covers which are associated with its surface. Briefly, these properties are appearance, protection of the core, finishability, and in some cases strength and stiffness.

Appearance: There are two ways in which the appearance of the product may be improved. First, an overlay may hide defects in the surface of the core material such as grain, knots, discolored areas or a generally undesirable color. Another visual effect which may be produced by overlays is creating a decorative surface. A wood grain, fabric design, or a brightly colored surface can be produced with overlays. Sometimes a translucent overlay will create an interesting effect by showing the natural surface of the wood beneath.

Although creating a decorative effect is seldom the sole purpose of an overlay, it is often an important consideration. An overlay is first of all a surface and the appearance of a surface is practically always important.

Protection: Protection of wood from deterioration is a matter of protecting the surface. If you protect the surface, you generally protect the whole structure. Protection from these deteriorating agents are of most importance: weather, wear, impact, and chemical attack. Overlays are custom made to shield against these agents. The overlay adds to the performance and service life of the product and often makes wood capable of performing jobs it could not do at all before.

Acting as a protective surface is the main function of overlays which contain appreciable amounts of resin.

Increasing Finishability: The ability of a wood surface to take and hold paints or finishes is of prime importance. Overlays can improve the paintability of woods because:

1. The color of the overlay surface is uniform and often lighter than that of the wood product it covers. A finished paint surface should be uniform in color and the more uniform and lighter the color of the surface it covers, the fewer coats it takes.

2. The surfaces of overlays have no grain. Unlike wood in which soft springwood and hard summerwood absorb different amounts of paint, overlays are uniform in paint demand over their whole surface.

3. Overlays may be treated to allow exactly the right amount of vehicle penetration and give a tailor made painting surface.

Increasing Strength Properties: Overlays used on single veneers give remarkable improvements in strength and stiffness. Although an overlay generally adds something to a product in terms of strength, this is usually significant only in cases like the single veneer where the core is quite thin and weak in at least one direction. In some cases an overlay can give an assembly of thick boards strength enough to permit handling even though from a structural standpoint this is not significant.

Overlays which contain a considerable amount of resin are improved in dimensional stability with respect to moisture content. Often an overlay will impart this stability to a core material to a surprising degree.[2]

Generally, improvement in only one or two of the properties listed above is desired for any specific product. In order to give specific improvements most economically, a wide range of overlays has been developed.

Overlay Types

Overlays may be described by their function, the product being overlaid, the thickness of the overlay, the resin content, or the resin type.

Of most interest to the overlay user is the purpose or function of the overlay since his main concern is in the improvement of some definite property in his product such as: strength or stiffness, resistance to surface deteriaration, surface appearance or finishability by painting, lacquering or perhaps printing.

There is in practice such an overlap of function in most overlay papers that a system of nomenclature has

[2] Heebink, B. G. 1954. Dimensional stabilizing effect of paper overlays when applied to lumber. Jour. of FPRS IV (3): 149.

grown up in which overlays are divided into four catagories. The basis for the separation is resin content of the base sheet.[3]

Any resin placed on the overlay for the specific purpose of acting as a gluline between the overlay and the wood product is disregarded. The classification shown in Table 1 is in good agreement with practice in the industry.

Economics of Overlays

A thorough economic study of overlays and overlaying processes is not the purpose of this paper. However, since the cost of producing an improvement in a product must be recoverable in added value at the point of sale, some idea of the cost of producing overlaid wood products is in order. The cost of producing an overlaid product depends more on the type of overlay being used than on the product being overlaid or any other variable.

Table 2 gives the approximate cost of overlaying 1,000 square feet with each of the four types of overlay. In using these figures, it should be noted that except for medium and low density overlays, one side surfacing has not been practical.

Table 2.—APPROXIMATE COST OF OVERLAYING 1000 SQ. FT.—CORE COSTS NOT INCLUDED

Type	Overlaid	Material Costs	Application Costs	Total Costs
I	2 sides	$47.50	$12.75	$60.25
II	1 side	20.25	4.20	24.45
	2 sides	40.50	4.20	44.70
III	1 side	13.25	4.20	17.45
	2 sides	26.50	4.80	31.30
IV	2 sides	6.51	3.10	9.61

Fields of Application

In light of what is known about the functions and economics of overlays, we can predict the growth of overlaid products now being produced and indicate areas for future developments.

Plywood: This year's production of overlaid plywood of all types is expected to be more than 50 million square feet. High and medium density are produced in about equal amounts and account for the major portion of the production.

High density overlaid plywood is used for two main purposes. The most important use is in cement forms where the resistance of the high density overlay to chemical attack is put to use. A steady expansion in production of this item can be expected since the trend in industrial construction is toward the finished concrete surfaces which high density overlaid plywood forms give.

[3] Seidl, R. J. 1947. Paper and plastic overlays for veneer and plywood. Proc. of FPRS

Photo courtesy of U. S. Forest Product Lab

Matched transverse sections taken from a 12-inch wide flat-grain white pine board, the left section not being overlaid (control) and the right section overlaid with resin-impregnated paper on both sides, showing restraint of cupping tendencies after both pieces have been exposed to high humidity on one side only.

Another use of high density overlaid plywood is for decorative and semi-decorative uses. This field is quite specialized so that very little decorative overlaying is done at the prime manufacturer's level. The main interest of the plywood manufacturer in decorative overlays is in production of core panels for furniture manufacture.

Surveys indicate that medium density overlay offers by far the greatest potential in the plywood field. The reason for this is that Douglas-fir plywood needs the protection of the overlay surface to withstand weathering. The glue in exterior plywood is waterproof but the veneer surface needs the protection of a medium density overlay. With this protection, exterior plywood can take its place as a fine exterior finish material.

Medium density overlaid plywood has been manufactured and sold for many years. During the past few years, the use of the product has broadened rapidly because of: the development of fine beveled and lap siding products made from medium density overlaid plywood, sales promotional work by the Douglas Fir Plywood Association, and expanded sales promotion by plywood and overlay manufacturers.

Low density and paper-overlaid plywood is at present of minor importance. There appears to be a potential market in the form of a special panel for the interior walls of prefabricated houses. The greatest economy in prefabricating houses comes about through the use of stressed skin panels in which the strength of plywood is necessary. A low density or paper overlay on the plywood would give the prefabricator an interior that could be finished on-site using standard drywall techniques while allowing the economies of stressed skin panels.

While the low density and paper overlays are not now widely used by plywood manufacturers, a potential market of over 100 million square feet per year will exist in the prefabricated home industry within the next ten years.

Single Veneers: An extremely vigorous development in the production of overlaid single veneers has taken place in the last few years. This product uses a paper or low density overlay to impart strength, stiffness, and printability to the veneer.

Some idea of the interest of box manufacturers in paper overlaid single veneer (usually referred to as K–V for kraft veneer) can be had by noting the trend in wooden box production figures. Last year the production of wooden boxes dropped off 110 million board feet with a drop of over 40 million board feet being reported in 1953.[4] This year an additional drop of about 5% is forecast in wooden box production. This inroad is attributed to a rapidly expanding use of corrugated paper cartons in the produce industry.

The corrugated case is completely satisfactory except that after refrigeration it tends to soften which seriously impairs its stacking properties. K–V

[4] Smith, E. R. National Wooden Box Assoc. 29th Annual Meeting.

Table 1.—CLASSIFICATION OF PAPER OVERLAYS BY RESIN CONTENT. PER CENT RESIN DEFINED AS (RESIN/RESIN + FIBER) (100)

Type	Description	Resin Content	Main Functions
I	High Density	30% or over	(a) Protection of surface from wear and chemical attack. (b) Decorative effects
II	Medium Density	15–30%	(a) Protection from weather (b) Paintability (c) Resistance to surface checks and cracks (d) Defect masking (e) Strength and Stiffness
III	Low Density	5–15%	(a) Strength and Stiffness (b) High wet strength (c) Limited weatherability (d) Paintability (e) Printability
IV	Paper	0–5%	(a) Strength and Stiffness (b) Printability (c) Ease of handling

affords the wooden box manufacturers an opportunity to fight this competition, the corrugated carton, with a complete K–V shipping case. It also makes it possible to join forces with competition and produce collars for stiffening and strengthening the corrugated carton.

The K–V industry is in such a state of flux now that it is almost impossible to make an accurate estimate of potential. Known production capacity of something over 250 million square feet, one shift basis, exists in the United States today. Many new plants are being built and planned so that it is safe to say that a production rate of well over a billion square feet of K–V per year will be reached within the next few years.

Lumber: Several applications of medium density overlay to lumber are under development. Although no large scale production has resulted as yet, experimental runs of overlaid siding and bleacher seats have been made. Use tests are encouraging and a good sized market for medium density overlaid lumber can be predicted.

The future of medium density overlay in the lumber industry depends on its ability to do three things which many species of lumber need to perform as an exterior finish lumber. These are: it takes and holds paint; it masks knots and seals them so they do not bleed pitch; it stabilizes lumber against cross grain dimensional change. Medium density overlay less than 0.020″ thick reduces swelling of some softwood species 25 to 40%.

As the more desirable timber stands are used up, we can expect more and more interest in overlaying from lumber producers. Development is expected to be slow since unlike the plywood producer who can swing into overlay production without buying new equipment, the lumber manufacturer must develop new methods and buy new equipment to overlay his product.

There is not likely to be much interest in high density overlays in the lumber field except in furnishing cores for the Formica type of surface. The reason for this is that the high density overlay on lumber is subject to checking and cracking.

There is a possible application for low density overlay in the production of shelving from edge glued panels. Overlaid shelving can be sold at some premium over straight lumber but probably not enough to pay for the overlaying unless No. 2 or 3 common lumber can be used as a core. Development of gluing and defect-filling methods now under way should make these products attractive within a few years.

Type IV or paper overlaid lumber may prove to be a workhorse despite the fact that the main property imparted by the overlay is ease of handling and application. No structurally significant strength is imparted to the lumber and the paper serves no protective or finishing purpose. Random width and length one inch boards can be made into panels for handling and application purposes by overlaying with a type IV overlay in a manner similar to the production of kraft overlaid veneer. This panel can be produced cheaply and gives much the same economies in application as does plywood sheathing.

Hardboards and Particle Boards: The field of hardboards and particle boards offers a wonderful opportunity for overlays. Wet-process hardboards are a sort of a plastic paper themselves and particle boards are close relations also.

A good deal of high density overlaid hardboard is now being produced. The main purpose is to impart a decorative effect although protection from wear and impact may also be a factor. Since hardboard offers the least expensive core material for this type of panel, continued growth in high density overlaid hardboards can be expected.

One of the problems associated with wet-process hardboards is their dark color and uneven paint absorption. Both of these problems may be solved by the use of an overlay. Costs are probably too high to permit overlaying for paintability improvement alone in a separate pressing step as is done with the type I high density overlay. Intensive development work is underway on type III and IV overlays which will be spread over the wet mat and pressed with the hardboard itself. One Canadian hardboard plant has been producing an overlaid hardboard of this type commercially for over a year. Commercial production is expected in the United States soon.

Particle boards are just beginning to reach their maturity in the wood products field. Until the last two or three years there have been only a few producers of this type of boards. The last two years have seen several new producers go into production and many more are in the construction and planning stage. Overlays of the medium and low density types can play an important part in the dry-process hardboard or particle board program.

In order to get a smooth surface on dry process hardboard, it is necessary to use a wood flake rather than the ground wood used in the core. Even then, there will be depressions in the surface where each flake stops which make the surface very difficult to finish. The use of a medium or low density overlay can relieve the problem of producing a special surfacing flake and give the particle board a fine surface for paint or enamel at the same time.

Summary

Paper overlays can impart valuable properties to plywood, lumber, single veneers, and hardboards. The most important functions of overlays are to protect from weather and wear, to act as a decorative surface, to improve finishability and to add strength and stiffness. Rapid expansion is taking place in overlaid veneer and in medium density overlaid plywood production. Commercial production of medium density overlaid lumber and hardboards will occur soon.

Around the World in Forest Products Research and Development

Move Under Way to Establish FPRS Section in Philippines

A group of FPRS members and interested persons in the Philippine Republic are working actively toward establishment of the 14th FPRS Section and the first outside of North America. Florencio Tamesis, Rosario Cortes, Gregorio Zamuco, Calexto Mabesa, and Eugenio de la Cruz, all of whom are charter members of FPRS, form the nucleus of the group of approximately 10 interested persons. Society by-laws require that 25 voting members residing in a geographic area must petition before a new Section can be established.

G. M. HUNT

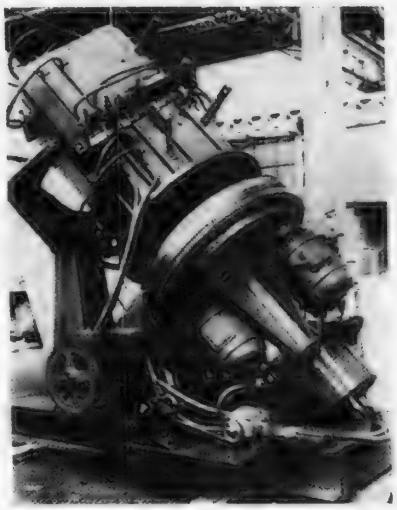
In another note from the Philippines, George M. Hunt, past Director of the U. S. Forest Products Lab., Madison, reports that steady progress is being made at the Forest Products Lab there. The laboratory will be ready for active research within the next few months, after installation of new equipment. Kenneth Boller, on leave of absence from the USFPL, Madison, will supervise the timber testing work. The staff will eventually include three Philippine men who are now training in the U. S., Hunt said.

French Firm Develops New Wood Chipper

A new, wood chipping machine that is said to produce uniform chips as thin as one-hundredth of an inch, and cut along the grain to preserve the natural fiber lengths, has been developed by the Guilliet Co., Auxerre, France.

The machine can handle various forms of woods, such as round timber, small wood, split logs, slabs, and sawmill residues, the manufacturers announce. With proper adjustments it can produce shavings of almost any size and shape, from very fine wood flour to chips of 2-inch length and 0.1 inch thickness or more.

Output varies according to the size of the desired product and the raw material used, and a single machine can produce as much as 6 tons per hour of 2-inch long chips, 0.025 of an inch thick, the manufacturer states.



The new Guillet chipper is shown without the exhaust hood, which is designed to fit particular needs.

The product obtained is ready for needs of pulp and paper, wallboard, plastics, tanning, and other industries.

Weighing about six tons, the machine stands 10 feet high, 10½ feet long and is 6½ feet wide. It operates with three electric motors, two 30 HP and one 1½ HP. The first machine on this continent is now being installed at the Abitibi plant, pulp and paper manufacturers, Sault Ste Marie, Ontario. Abitibi has also ordered a second machine for its Sturgeon Falls, Ont., plant.

Selbo Reports on Swedish Plastics Federation Meeting

M. L. SELBO

Magnus Selbo, chemical engineer at the U. S. Forest Products Lab currently on a Fulbright Fellowship Award to the Norwegian Institute of Wood Working and Wood Technology, Oslo, Norway, wrote recently: "I thought of FPRS several times when I attended the annual meeting of the Swedish Plastics Federation. I know what headaches large meetings can be but I expect it is even more complicated to arrange large meetings here in Europe.

"More than 50 papers were presented at this meeting in either Swedish, English, German, or Norwegian. Flags of 12 different nations were displayed along the speakers' table as 12 countries were represented, five persons from the U. S., including myself. Each speaker was introduced in his own native tongue by the secretary of the Swedish Plastics Association. Speeches were given by the presidents of the plastics societies of Great Britain, Sweden, Germany, Norway, Denmark, and the chairman of the international relation committee of the plastics industry society of the U. S."

Selbo is helping organize research programs on gluing and wood technology for the Norwegian government. He is expected to return to the U. S. in June.

Scanning World-Wide Forest Publications

NORWAY

Norsk Skogindustri. V. 9, No. 8, August, 1955. Diffusion of Sodium Chloride in Wood Fibre Boards and Plywood. Part 2—Diffusion through Surface-coated Boards. O. L. Johansen and Dr. Nat. V. B. Kumar.

In Part 1 of this report (October, 1955 FOREST PRODUCTS JOURNAL), the diffusion of sodium chloride through some common varieties of wood fibre board was described; Part 2 deals with the diffusion of the same salt through some boards coated with high polymeric substances, i.e., phenol formaldehyde, urea, hydrocarbon waxes, asphalt, polyethylene, polystyrene, polyvinyl acetate.

It was found that the waxes and polyethylene offer excellent initial resistance to the passage of the ions but their impedance shows deterioration after some time. Polyvinyl acetate water emulsion and phenol formaldehyde coated on both sides of the boards gave all around good resistance to the ionic diffusion. The other treatments had rather high diffusion contants.

The Norwegian Institute of Wood Working and Wood Technology. Report of Research in Progress in 1954. Joh. Nordhals Trykkeri, Oslo, 1955.

Sawing Precision. Extensive use has been made of apparatus constructed for continuous registration of sawing precision. The apparatus is based on the use of strain gauges mounted on a special fork-shaped pickup of spring steel and has worked entirely satisfactorily. A similar apparatus for measuring the

thickness of wallboards has been in experimental use for a considerable length of time.

Planing With Rotating Cutter Instead of Fixed Knives on Face Side of Boards. This method has now been introduced, and a study made regarding the power consumption, utilization of raw materials, and grading result, a comparison being made with the usual method employing stationary knives. It was borne out by the results that the method led to a better utilization of raw materials.

Investigations Concerning the Recovery with Ordinary Planing Methods. Sawing precision is one of the factors affecting the recovery of planed lumber as calculated on the basis of the raw plank. The experimental measurings carried out so far have shown that this factor does not change during the drying process.

Air-drying of Lumber. The experiments concerning the weighing of whole plank stacks by means of electronic load cells based on strain gauges have improved the possibilities for studying more closely the drying process in open-air drying.

Absorption of Moisture in Kiln-Dried Floor Planks During Storage. In order to examine the possibilities for maintaining low moisture contents in the floor planks until laid in the floor, an experiment was conducted regarding the storing of floor planks under different conditions at the working places. The results have been published.

Fuel Briquettes of Sawdust and Planer Shavings. So far the work has been directed towards obtaining a good and cheap binder. The Institute will now be furnished with a small plant for the making of fuel briquettes from sawdust and shavings, consisting of a kiln dryer, a disintegrator, and a briquetting press. The aim is to investigate alternative methods for the drying of sawdust.

JAPAN

Wood Industry, V. 10, No. 10, 1955. Studies on the drying of veneer by machine—Iron plate breathing dryer. Haruo Watanabe, Ryo Miura.

On the drying of veneers using iron plate breathing roll dryer, drying rate of sen, shina and birch veneers is greatly affected by the initial weight of moisture to be evaporated in veneers. As the weight of moisture present in green veneer when veneer thickness increases, drying rate decreases relatively to its thickness.

S, the drying rate of 1.3 mm birch and sen veneer are 0.15–0.17 at 130–140° C, and 0.28–0.30 g/min.^{2} at 140–150° C., calculated from the equation, S equals $2W/T^2$, where W gram., moisture to be evaporated; and T minutes, time required for evaporating W. gram moisture. The steam consumption for evaporating 1 kilogram moisture is observed to be about 2.4 kilograms, which seems to be higher than other roller type dryers. Shrinkage characteristics on this veneer dryer seem not to be as different as other types of dryers, but uneven drying is often found. Moreover, it seems to be inevitable to avoid the defects caused by cracking, because there was not adequate forced air circulation.

Wood Industry, V. 10, No. 11, 1955. Mechanical drying of veneers —the Roller Dryer. Haruo Watanabe, Ryo Miura.

Observing the roller dryer of longitudinal air circulation type, having 12 sections of 3 lines, the value of drying rate "S" is 1.3 of Sen, 0.84 of Shina and 0.97 g/min. of Birch, all of 0.9 mm. veneer at 120° C. "S" is proportionally increased with drying temperature, being doubled by elevating 20° C., while "S" decreases relatively to the increasing veneer thicknesses.

Shrinkages of veneers are ordinary and splits are not so large as with the iron plate dryer, having 13 sections of 5 lines. Some examples of standard drying schedule on this dryer include 4–6 min. in Sen, 7–9 min. in Shina at 0.9 mm. thickness and 120° C., expecting moisture content to be under 15%.

Moisture removed in this dryer amounts to nearly 400 kg/hour, treating 15,000 sq. ft. of 0.9 mm. veneers at triple capacities of iron plate dryer. Steam consumption reaches about 2.3 kg. per kg. moisture removed, which seems to be nearly equal to the iron plate dryer. Roller dryer, however, is advantageous mainly owing to its forced air circulation.

Wood Research Society Organized in Japan

The Japan Wood Research Society was established last April to promote forest products studies in Japan, with Takeo Ogura as Director. The Society is publishing a quarterly magazine, "Journal of the Japan Wood Research Society."

Discusses Chipboard Properties

An abstract of an article by Kakuichi Kitahara on "The Relation of Hot-Press Conditions and Physical and Mechanical Properties of Chip-Board," from V. 1, No. 1, follows.

The author has studied the relations in an effort to get better hot-press conditions such as would give chipboard more moisture content. Chipboard has a tendency to warp when it absorbs moisture from the air, but it will hold to the flat plane if it has a moisture content approximate to the equilibrium content when taken out of the hot-press.

Conditions of the experiment were as follows: Raw material species used were Ezomatsu (*Picea Jezoensis* Carr.) and Todomatsu (*Abies sachalinensis* Fr. Sch.). The ratio was 1:1. The chip was shaved by Grupp shaving machine; the binder was urea-resin and its hardener, the resin content of which, without solvent, was 11% to the oven-dried weight of the chips. The weight of chips of a chip-board 26x38x2 cm. was 1190 g.

The moisture content before pressing was 19%. Pressure was increased until the distance piece (stopper) touched the upper hot-plate, and at that time it was about 15 kg/cm^2. After keeping it there five minutes it decreased to 5 kg/cm^2.

In the pressing temperature experiment, changes made were 100, 140, 180, and 220 C, with the cycle time kept constant at 15 minutes. In the press cycle time experiment, changes made were 5, 10, 20, and 30 minutes with the temperature kept constant at 140° C. Then, in the next case the times were 5, 10, and 15 minutes with the temperature kept constant at 180° C. In the first of these—the 5 minute duration—the chip-boards were not prepared completely, and a separating appeared in the middle of them at 5 minutes.

After one week, the physical and mechanical properties were tested. Results obtained were as follows:

1. Thickness after pressing. When the temperature is low and the cycle time short, the thickness is much bigger by spring-back of chips than that of distant piece. But in the contrary case, it is smaller by compression shrinkage of chips than that of distance piece.

2. The relation of specific gravity and pressing condition. When the temperature is high, it decreases by the decomposition of the chips: when the temperatures are constant, at 140° C and 180° C, and the cycle time is changed, the curves go up. But with a longer cycle time they will go down again.

3. The relations of moisture content and pressing condition. In all cases the curves go down sharply. But in this experiment the moisture contents are rather high as compared with general chip-board, that of raw material being too high.

4. The surface of chip-board takes on fragility at higher temperatures. This was tested by the author by the ratio (%) of decreased weight to the initial of the chip-board, using abrasing sandpaper (# 60) along the 15 cm line.

Abstracts From Current World Literature

Veneer and Plywood

W. T. Curry. The strength properties of plywood: part 2. Effect of the geometry of construction. *Forest Products Research Bulletin,* No. 33, 1954.

This investigation is concerned with the development of suitable equations for calculating the bending, tension, compression and shear strength of plywood. The investigation was limited to conventional constructions, i.e. plywood made from rotary cut veneers laid alternately at right angles. The theoretical development of the equations is shown in some detail in order to illustrate the method of approach to plywood design, and to indicate the limitations of the results. The equations for the four properties concerned are conveniently listed at the end of the text and the meanings of the symbols involved are given at the front of the booklet.

The first appendix gives examples showing the application of the equations in specific cases and the second appendix contains references to some statistical methods of determining the degree of accuracy which can be expected from the results. [F. D. C. Tech. Bul. V. 5, No. 25]

Construction

Stanley, M. S. Engineering laminates, in particular glued laminated timber construction. *Aust. Timb. J.* 20 (8), 1954.

A lecture to the Institute of Engineers, Australia, covering *inter alia* advantages, applications, gluing, nailing v. clamping for pressure, selection of timber, joints, timber columns, jigs, permissible stresses, relation of strength to curvature, box-form cross-sections, curved members for 150-ft. spans, durability, design, plywood webs, and tests. [For Abs. V. 16, No. 2]

Waste Utilization

Davey, C. B., and Wilde, S. A. Sawdust compost helps tree seedlings grow. *Rep. Wis. Agric. Exp. Sta. 1952/53* Part 1, 1954 (45). (*Bull. Wis. Agric. Exp. Sta.* No. 510.)

Acer saccharum sawdust was first treated with anhydrous NH_3, H_3PO_4 and commercial fertilizer salts and then inoculated with wood-rotting fungi. After 6 month's fermentation, the material carried ca. 3 lb. N, 1.5 lb. available P, 5 lb. available K, and a wealth of effective organic matter per cu. yd. Composted sawdust stimulated nursery seedlings to grow as much as 9 times as fast as untreated controls. Applications ranged from 5 to 60 cu. yd./acre. More than 30 cu. yd./acre tended to produce succulent seedlings that might not transplant well; 20 cu. yd./acre would probably be the best rate for Wisconsin forest nursery soils. [Cf. *For. Abstr.* 15 (No. 801).] [For. Abs. V. 16, No. 2]

Wood Chemistry

The literature of cellulose and other materials related to the pulp and paper industry. *Tappi* 37 (9), 1954 (152*A*–196*A*).

Includes the following: The literature of cellulose and related materials (*W. M. Hearon*), tabulating journals and special publications covering this field; Abstract services covering the chemistry of cellulose and related fields (*C. L. Brown*), with an appendix listing 207 abstracting publications; The literature in the field of cellulose and its related materials (*E. C. Jahn* and *C. V. Holmberg*); Available bibliographies in the cellulose, pulp, and paper fields (*J. Weiner*) (over 600 items); The literature spectrum of cellulose chemistry (*H. Skolnik* and *L. M. McBurney*); and the path of the searcher in the literature (*G. J. C. Potter*). [For. Abs. V. 16, No. 2]

Schönbach, H. Cellulose studies on individual stems and clones of poplars. Z. *Forstgenetik* 3, no. 6: 139–40 (Dec. 1954).

Reference is made to studies at Graupa in Germany for predicting certain important properties in new poplar hybrids, particularly the content of pure cellulose (I). The analytical methods according to Schmidt and Kürschner were found unsuitable for mass analyses on living trees. A special method for this purpose (details not given) was developed by the Institut für Fasertoff forschung in Teltow–Seehaf. However, the results of these mass analyses are of no great help to the breeder, because the values vary greatly within each stem. Early diagnoses on one or two-year old wood (desirable for breeding purposes) also seem to be impossible, because the cellulose values change in different ways with increasing age. According to presently available results by different investigators, (I) increases with increasing age up to 15–20 years, when a maximum is reached, whereupon it decreases again. Experiments with over 100 clones at Graupa (now in their fourth year) show in most cases the same tendencies for increases in (I), although the rate varies with the individual types. Among these types certain clones were found which showed an above-average increase during all four years of growth; a close check will be kept on them to see if these tendencies continue in the future. The author's results with the Teltow method show that the species and hybrids of the section *Tacamahaca* (the balsam poplars) exhibit high (I). However, (I) determinations on two-year old hybrids of the section *Leuce* (the white poplars and aspens) have also shown maximum values of 44% (I). In studying the recent work of Klauditz and Stolley (*cf.* B.I.P.C. 25: 648), the impression may be gained that site conditions exert the dominating influence upon (I). The present data indicate that considerable differences by species and types exist which may be profitably utilized for breeding purposes. [Bul. Pap. Chem. V. 25, No. 11]

Chang, Ying-Pe, and Mitchell, Raymond L. Chemical composition of common North American pulpwood barks. *Tappi* 38 (5): 315–20. May 1955.

Components determined in 9 softwood and 15 hardwood barks were as follows: ash, extractives, lignin, methoxyl in lignin and bark, and the amount and composition of the reducing sugars produced from extractive-free bark by 72% sulfuric acid. The hot-water extract was tested qualitatively for tannins by two methods. Solubility of bark in 1% sodium hydroxide and the amount of precipitate obtained by acidifying the alkaline extract were also determined. Heat of combustion values were measured for 8 softwood and 12 hardwood barks. Most of the barks contain relatively large amounts of ash, extractives, lignin, and material soluble in 1% sodium hydroxide. The high solubility in alkali, exceeding 50% for 7 barks, suggests a potential means for utilizing these barks. Apparent trends in the relation of chemical composition to physical structure of bark are discussed briefly. [Bul. Pap. Chem. V. 25, No. 10]

Barking

Bott, Rudolf. Industrial debarking of wood. *Holz Roh- u. Werkstoff* 13, no. 4: 147–60 (April, 1955).

With reference to increasing demands for wood and diminishing supplies in many parts of the world, the need for economical barking methods and the use of poorer qualities of wood hitherto not considered suitable for pulping are discussed. The principal barking methods and their advantages and disadvantages are described under the subheadings: knife barking (manual or by machinery), friction barking (with the aid of hard friction elements or by mutual friction of the logs), hydraulic barking, and chemical barking of living trees, listing representative equipment and proce-

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The preparation of abstracts from world literature in many languages is so highly specialized and costly that the Forest Products Research Society has no abstracting service of its own. For the abstracts in this issue of the JOURNAL the Society is indebted to the respective abstract journals indicated, from which they have been selected with the kind permission of the editors. Readers wishing information in addition to that given in these abstracts should consult the original articles referred to. Copies or additional information can not be supplied by FPRS or the abstract journal. The journals from which abstracts are published in this issue are as follows:

BULLETIN OF THE INSTITUTE OF PAPER CHEMISTRY, published monthly at Appleton, Wisconsin by the Institute of Paper Chemistry, subscription price $25 per year. This Bulletin publishes over 3,600 abstracts per year on subjects of interest to manufacturers of pulp, paper, fiber board and allied products.

CHEMICAL ABSTRACTS, published semimonthly by the American Chemical Society, Executive Office—1155 Sixteenth Street, NW, Washington 6, D. C., subscription price $60 per year plus postage. This abstract journal publishes many thousands of abstracts annually with broad coverage of world literature in the entire field of chemistry and allied subjects.

FORESTRY ABSTRACTS, published quarterly by Commonwealth Agricultural Bureaux, Farnham, Royal, England, subscription price $8.40 per year. The abstracts are prepared by the Commonwealth Forestry Bureau, Oxford, England, and include a Forest Products and Utilization section. This section contains about 1,200 titles and abstracts per year from literature in some 30 languages, covers all aspects of forest utilization.

TECHNICAL BULLETIN OF THE FURNITURE DEVELOPMENT COUNCIL is published bimonthly by the Council at 11 Adelphi Terrace, London W. C. 2, England. The Technical Bulletin publishes hundreds of abstracts and reviews from world literature annually, relating to the various phases of the furniture manufacturing industry. Subscription price is $5 per year.

dures in each case. Suitable pretreatments (soaking in warm or cold water for extended periods or exposure to steam or hot water for brief periods) are also considered. [Bul. Pap. Chem. V. 25, No. 11]

Seasoning

The movement of timbers. *Forest Products Research Laboratory,* Leaflet No. 47, September 1954.

Although the extent of the shrinkage of wood in drying usually gives some general indication as to whether the movement in service will be large or small, it has been found that this earlier shrinkage and the subsequent movement of the seasoned timber are not directly related to one another. Tests have been carried out at F.P.R.L. to find the tangential and radial shrinkage of samples of over 100 timbers dried from the equilibrium moisture content in 90% relative humidity to that in 70% relative humidity. The results are presented in a table.

For purposes of comparison the timbers, which include both hardwoods and softwoods, are then grouped in three classes according to the amount of movement exhibited. In the first, or small movement, class come the species in which the sum of the percentage radial and tangential movements is less than 3.0%. For those in the medium class, this value is 3–4.5% and if the sum is above 4.5% the movement is considered to be large.

It is pointed out that timbers in the small movement class will not necessarily show least distortion, since this latter property depends on other factors such as grain direction and the presence of knots. [F.D.C. Tech. Bul. V. 5, No. 25]

Hardwood Pulping

Hardwood pulping for the Northeast. [Papers presented at the Hardwood Pulping Conference at Amherst, Mass., on Sept. 14, 1954.] *Paper Tr. J.* 138 (42), 1954 (42 . . . 62).

Includes the following: Hardwood timber resources in the Northeast and their availability for pulpwood (*J. R. McGuire*); Hardwood pulpwood procurement in the Northeast (*F. C. Simmons*); Hardwood disposal—a pressing forestry problem (*C. L. Tebbe*); Chemi-peeling hardwood (*D. B. Cook*) and Pulping processes for Northeastern hardwoods (*G. H. Chidester*). [For. Abs. V. 16, No. 2]

Bergek, T. Björken som ravara för massaframställning. [Birch as raw material for pulp.] *Norsk Skogind.* 8 (11), 1954 (372–9).

Discusses chemical and structural differences between Birch and Spruce wood and their effect on pulping, the types of paper for which Birch can be used, recommended pulping processes, quality requirements as regards barking, decay and resin content, and costs. [For. Abs. V. 16, No. 2]

Silviculture

LaFond, Andre. Industrial silvicultural treatment—their costs. *Pulp Paper Mag. Can.* 56, no. 6: 168, 171–2 (May, 1955).

Experience gained on pilot-areas indicates the economic soundness of the application of silvicultural treatments on an industrial basis. By observing a few general principles it is possible to determine whether or not silvicultural treatments should be applied to definite areas and whether the application has a sound economic basis. Important steps before starting experiments on a large area include the determination of main site groups and their extent, establishment of site maps, and careful study of growth. Application of silvicultural methods involving short cutting cycles appears to answer the problem of maintaining and perhaps lowering the cost of wood production, satisfying the increasing demand for raw material, and stabilizing labor. [Bul. Pap. Chem. V. 25, No. 11]

Forest Genetics

Swan, H. S. D. Tree breeding—what prospects does this science hold for the Canadian pulp and paper industry? *Pulp Paper Mag. Can.* 56, no. 6: 154, 157, 160, 163–4, 166 (May, 1955).

General principles in the field of tree breeding are discussed under the two broad objectives—the genetic improvement of naturally reproduced stands and the production of improved forest trees for planting. Experiments in the growing of hybrid trees are discussed, and the fact that the exceptional rates of growth obtained can only be obtained on the most suitable sites is emphasized. An increased yield as a result of tree breeding seems to be a possible answer to the substantial increase in pulpwood requirements expected during the next 50 years. 1 table and 11 figures. [Bul. Pap. Chem. V. 25, No. 11]

Extractives

Barnes, Roderick A., and Gerber, Nancy Nichols. The anti-fungal agent from Osage orange wood. *J. Am. Chem. Soc.* 77, no. 12: 3259–62 (June 20, 1955).

The wood of the Osage orange, *Toxylon pomiferum,* has been found to contain approximately 1% of 2,3′,4,5′-tetrahydroxystilbene. This substance was toxic to five of 13 micro-organisms which were tested and its presence is believed to be the main reason for the remarkable resistance of Osage orange wood to decay. [Bul. Pap. Chem. V. 25, No. 11]

Properties

Pycnanthus (*Pycnanthus angolensis*). *Wood,* Vol. 20 No. 1, January 1955.

Pycnanthus is a W. African timber which is white when freshly cut and darkens to a pinkish-buff or nut-brown colour on exposure. The grain is fairly straight and the wood soft and light in weight, sometimes no more than 24lb per cu ft when air dry. It is easily seasoned and works well, although it is slightly woolly. The timber is firm, but the strength properties are not high. It is suitable for rotary cut veneers for utility plywood, and for hidden parts in the cheaper grades of furniture. *P.angolensis* is also known as *P.kombo*, and an alternative common name is ilomba. [F. D. C. Tech. Bul. V. 5, No. 25]

Elgon olive (*Oleo welwitschii*). *Uganda Forest Department.* Timber Leaflet No. 23, November 1954.

Elgon olive, or loliondo, is a timber suitable for heavy furniture and joinery. Selected and matched boards are excellent for decorative panelling and cabinet work although this requires considerable skill. The sapwood is yellowish white and the heartwood yellow-brown to pale red-brown with dark brown streaks, similar in appearance to E. African olive (*O.hochstetteri*). The timber is hard and fairly heavy, weighing about 50 lb. per cu ft when air dry.

Loliondo has very good strength properties, but when strength is important the timber should be thoroughly inspected for excessive slope of the grain. It seasons readily with little shrinkage. Working is difficult by hand or machine, but a fine finish can be obtained if cutting edges are kept sharp. A blunted nail is said to penetrate more easily than a sharp one, and for good quality work pre-boring is necessary before nailing or screwing. [F. D. C. Tech. Bul. V. 5, No. 25]

Hearmon, R. F. S., and Burcham, J. N. The dielectric properties of wood. *Spec. Rep. For. Prod. Res., Lond.* No. 8, 1954.

Measurements of permittivity and loss tangent on 12 species of wood, in the 3 grain directions, at moisture contents (m.c.) up to 18%, and over the frequency range 2 kc./s to 60 Mc./s are summarized and discussed. The results for Sitka Spruce and Oak are presented in some detail. The permittivities change uniformly with m.c. and frequency; they are closely related to density, and a method is suggested which enables the permittivities of any timber to be predicted approximately in terms of density, m.c. and frequency. The variation of loss tangents with density, frequency and m.c. is less regular, and it is not possible to predict values of these quantities with any accuracy. Results of measurements on wet woods show extremely large variation in permittivity and loss tangent with frequency, but the conductivity depends much less on frequency than it does for dry wood. The dielectric behaviour of dry wood can be qualitatively described in terms of the dipole theory, but as the moisture content increases, the effect of ionic conductivity becomes more and more important. [For. Abs. V. 16, No. 2]

Pavlov, V. P. Soprjazenie drevesniy podline na zubcatyi sip. [Multiple-scarf joint used for joining timber lengthwise.] *Derev. lesohim. Prom.* 3 (10), 1954 (5–8).

Presents in graphs the results of an investigation on the effect on tensile and bending strength of (1) the scarf-tooth slope, (2) blunting of the tooth edges and (3) tooth length, in glued multiple-scarf joints. Change of the tooth-spacing/length ratio of a multiple-scarf joint from 1/16 to 1/8, had no effect on the strength properties, but when this ratio exceeded 1/8, strength began to fall. Blunting of the scarf-tooth edges to a width > 0.5 mm. also reduced strength. Length of joint (length of tooth) had hardly any effect on strength for length values 1–14 mm.; below 1 mm. the strength fell rapidly towards the value for the end-on joint. A pressure of 3–6 kg./sq. cm. of cross-section is recommended for joining timber with the multiple-scarf joints. [For. Abs. V. 16, No. 2]

Finishing

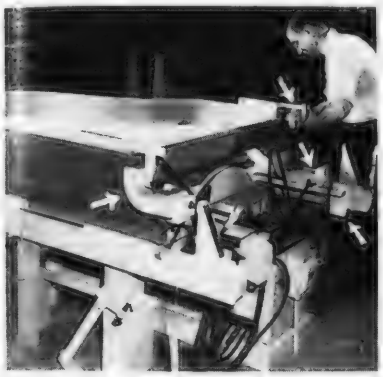
Lüthgens, M. Untersuchungen über Blasen- und Rissbildungen polierfähiger Lackfilme auf Holzoberflächen. [Investigations on the formation of blisters and cracks in polishable lacquer films on wood surfaces.] *Holz Roh- u. Werkstoff* 12 (7), 1954 (271–7).

Blisters or bubbles formed sometimes when temperatures $> 60°$ C. are used to speed up the drying and setting of lacquer films on wood, were examined microscopically, and classified into (1) minute ones generated inside the film itself, and (2) larger ones formed under the film by air inclusions in the tracheids (particularly in the case of ring-porous and tropical woods). Both can be prevented by an appropriate gradual increase of temperature and by filling the pores. The following were found to cause cracks in lacquer films: (1) the composition of the lacquer itself, (2) transfer of wood stresses, and (3) cracks in veneer. [For. Abs. V. 16, No. 2]

FPRS News-Digest, Continued

New Resistance Heaters

Time, labor and floor space are reported saved with new resistance heaters installed by Steinway & Sons, Long Island City. The photo below shows a veneering jig built by Steinway craftsmen, with a custom-built Washburn transformer and cables at lower right. Arrows point to wood pressure blocks faced with stainless steel heating elements. Not shown are two long, heated pressure blocks for veneering



the top edge of the piano rim. The heaters cure the urea resin bond in less than a minute, and only one clamping jig is required instead of four.

The simple, low cost equipment uses low voltages so there is no danger to employees of shocks or electrical burns. Complete heating equipment, including the transformer, cables, and heater strips, was made by Washburn Electric Co., Englewood, N. J.

Potential Research Fields Listed in New Booklet

Eight specific fields "ripe for research and development" are charted for lumber and wood product manufacturers in a new publication, "Guideposts to Wood Markets," issued by Timber Engineering Company, 1319–18th St., N.W., Washington 6, D. C. Copies are available without charge.

Particular emphasis is given in the booklet to developing ways of converting low-grade lumber and wood residues into new and improved wood products. Wood particle board development is cited as a major area needing continued research, to enable it to achieve its broad market potentials.

Other fields in which research promises considerable benefits, according to the Teco booklet, include new glues and gluing processes for faster, more economical gluing and laminating; ultrasonics in non-destructive testing and stress grading structural timbers; possible uses of radioactivity; new seasoning methods; chemical and mechanical utilization of wood residues and low grades; wood pallets; and development of new wood products.

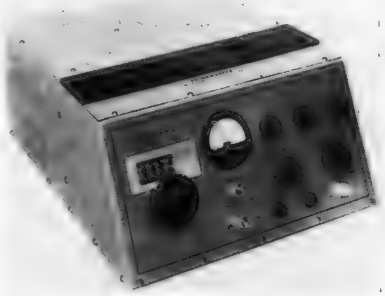
Machining Idea Booklet

A 16-page new idea booklet has been issued by DeWalt, Inc., Lancaster, Pa., manufacturers of woodworking machinery for industrial and home shop use. The free booklet, entitled "New Ways to Make Money on Your Cutting Jobs with 'Job-Tested' AMF DeWalt Methods", is available from DeWalt dealers or the home office.

The booklet points out various ways to reduce costs and increase profit margins. A major portion discusses considerations investigated by management when selecting equipment. Specific topics include: floor space savings, installation costs, obsolescence, operator fatigue, safety, material flow, waste and salvage, quality control, portability, versatility, and reduced 'downtime'.

Color Measuring Gauge

A color measurement device more sensitive than the human eye has been developed by Manufacturers Engineering & Equipment Corp., Hatboro, Pa. The Colormaster Differential Colorimeter, model IV, measures the color transmission and reflectance of such

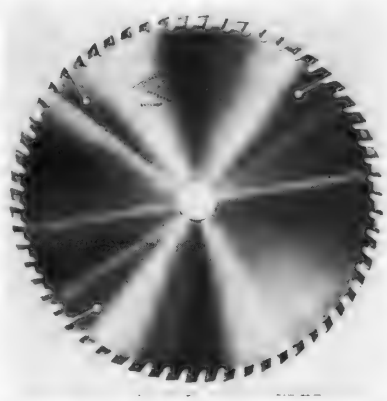


substances as synthetic fibers, paints, liquid solutions, pigments and slurries within 0.0001 reflectance units.

The manufacturer reports that the new model is particularly improved in sensitivity in measuring dark samples. Other new features include a simplified switching arrangement and an easily read reflectance indicator calibrated to 0.0002 reflectance units.

Carbide-Tipped Saw

A new, carbide tipped saw for all hand-feed and radial arm saw operations has been developed by Victory Carbide Saw & Tool Co., Cliff Vanderwerker, Jr. has announced. The saw cuts a thin kerf, alternating rough and finish cutting teeth to divide the work and thereby give easy, free,



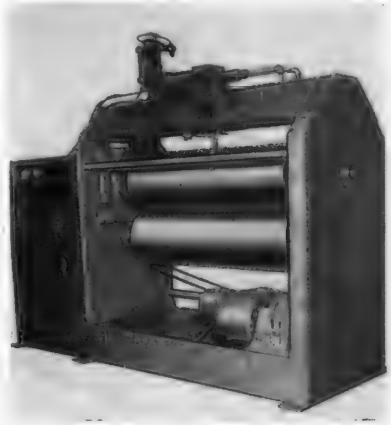
smooth, and safe cutting. Engineered for ripping, cross-cutting, and mitering, production is stepped up on all types of materials, such as laminated plastics, plywoods, hard and soft woods, compositions, fibres, and nonferrous alloys.

The manufacturer reports that the new saw allows sufficient clearance on both tops and sides of teeth to eliminate burning while cutting. The saw cuts up to 50 times longer between sharpenings as compared to steel saws, it is claimed.

Continuous Laminating Machine

A new gas-fired roll laminating machine for manufacturing wall and acoustic tile has been developed by the Union Tool Corp., Warsaw, Ind. It is designed for any continuous laminating process, and will adjust to take material up to two inches in thickness.

The machine is hot pressure-roll type with two 16-inch diameter rolls 54 inches long. Pressure is supplied to the top roll by two 4-inch hydraulic cylinders and a booster arrangement from the plant air line which provides about 16,000 lbs. pressure on the roll. The gas burner heats the top roll 350° to 450° F., with the machine set at 75 l.f.p.m. standard speed.



FPRS News-Digest, Continued

Cutterhead Grinding Fixture

A new gauge index for grinding cutterheads has been developed by Dependable Machine Company, Greensboro, N. C., according to C. G. Monnett, Jr., vice president. Monnett reports that the G–12 fixture is adaptable to practically all cutterhead grinders, and will handle heads with bores from one-half inch to 2½ inches and up to 12 inches long.

The fixture has a 12-notch sleeve suitable for grinding heads with 1 to 12 knives. Extra equipment includes a spring pointer mechanism, roller setting gauge, dial indicator, and diamond wheel dresser. A special Jacobs Chuch arbor is furnished for grinding router bits, drills and other straight shank cutters.

Sawmill Equipment Catalog

Sawmill equipment designed to fill the needs of every sawmill operator is described in a new catalog available from Electric Steel Foundry Co., Portland, Ore. First of its kind released by the firm, the catalog is organized in three divisions. The Conveyor Equipment section includes chain, flights, sprockets, and drums. Described under Log Haul Equipment are log haul chairs, sprockets, drums and slip liners, and return rails. The third section shows such equipment as nigger bars, carriage wheels, hog rotor, refuse chain, and spiked rolls.

The new catalog, No. 148–A, also contains photos of the equipment in operation. Copies are available from any ESCO representative or the home office.

Insulated Tank

A light, strong, rustproof, insulated tank made of Reichhold plastic has been developed to serve as a portable container for hot or cold liquids. It is being widely used in the outdoor advertising industry, since paste used in posting large signs must be kept hot.

The tank, which has a capacity of 129 gallons, is partitioned into two compartments. Its basic frame is pressed wood and the interior consists of fibrous-glass-reinforced polylite resin made by Reichhold Chemicals, Inc., 525 N. Broadway, White Plains, N. Y. The exterior also is coated with polylite, pigmented to make painting unnecessary.

The unit is manufactured by Calumet Fiberglass Products Co., Hammond, Ind. Calumet is also using Reichhold polylite for lining truck interiors against rust and corrosion.

NEW PUBLICATIONS

High-Temperature Drying of Lumber. J. L. Ladell. Forest Products Laboratories of Canada. Presents conclusions of preliminary studies in kiln drying commercial timbers at temperatures above the boiling point of water. Reprint from Timber of Canada.

The Strength of Fire-Killed Timbers. W. J. Smith. Forest Products Laboratories of Canada. Reprint from Prairie Lumberman.

The Structure of Wood. J. D. Hale. Forest Products Laboratories of Canada. Describes differences in physical and mechanical properties of various species. Reprint from Timber of Canada.

Effectiveness of Flooring Nails in Plywood Subflooring. E. George Stern. Bull. No. 21. V. P. I. Wood Research Laboratory, Blacksburg, Virginia.

Statistical Summary of Lumber and Hardwood Flooring, 1951-1955. National Lumber Manufacturers Assoc., 1319 18th Street N. W., Washington 6, D. C. Reports latest revisions of the industry's estimates of total production, shipments, new orders, unfilled orders and gross stocks by producing regions.

Insect Damage in Hardwood Sawlogs. C. John Hay and J. F. Wootten, Tech. Paper No. 148, Central States Forest Experiment Station, Columbus, Ohio.

Tension Wood in Eastern Cottonwood. Margaret Kaeiser and Maxon Y. Pillow. Tech. Paper No. 149, Central States Forest Experiment Station, Columbus, Ohio.

Michigan Forest Survey. C. D. Chase and A. G. Horn. Lake States Forest Experiment Station, University of Minnesota, St. Paul 1, Minnesota. Report of timber resources of Houghton and Keweenaw Counties, Michigan.

PROFESSIONAL CARD

W. H. RAMBO
INDUSTRIAL PLANT ENGINEER
Specialist in
Furniture & Woodworking Plants
Sawmills, Veneer Plants
Paper Mill Wood Rooms
Hard Board Plants & Wood Preserving Plants
Design, Supervision of Construction
Reports & Surveys
Loyalty Bldg. Portland 4, Ore.

Opportunites in Wood Waste. W. R. Smith, G. Englerth, and M. Taras. Southeastern Forest Experiment Station, Asheville, N. C. A complete summary of wood residue in North Carolina.

National Forests of the Southern Region. Region 8, Forest Service, Atlanta, Ga.

Native Land. National Association of Manufacturers, 2 East 48 St., New York 17. Available in quantities with company name imprinted at slight additional cost. Prices: $8 per 100; $65 per 1000. Contains information on forests, water, soil, wildlife, national parks, and job opportunities in the conservation field.

Ohio's Timber Harvest Revealed in Stumps. Kenneth L. Quigley. Central States Forest Experiment Station, Columbus, Ohio. Presents stump-survey data collected in testing new method of determining timber cut by measuring stumps on logged areas. Information from a conventional industry canvass of timber production is also given.

Tomorrow's Technology: A Symposium. Southern Research Institute, Birmingham, Ala. Papers on: Business Application of Large Computers, The Water Resources of the South, Air Pollution, and Nuclear Power for Industry.

Forestry Handbook. Ronald Press Co., New York 10. $15. Organizes compactly the essential facts of forest management, silviculture, wildlife management, watershed management, forest recreation, logging, aerial photography, and important related subjects. Edited for Society of American Foresters by over 140 consulting and contributing editors. 1220 pages, 744 illustrations and tables, 23 indexed sections.

The Nation's Wood Preserving Industry. American Forest Products Industries, Inc. 1816 N. Street N. W., Washington, D. C.

Homes of Permanence and Beauty. Timber Structures, Box 3782, Port

land 8, Ore. Eight-page brochure shows applications of glulam beams and heavy timber decking in construction of modern homes.

More for Your Money with the Modern Wood School. National Lumber Manufacturers Association, 1319 18th St. N. W., Washington, D. C.

Properties of Dry-formed Hardboard with Various Resin Contents. L. G. Frashour, W. H. Cooke, and C. R. Morschauser. Oregon Forest Products Laboratory, Corvallis, Ore.

Pulp Chips from Veneer Waste. J. A. Holekamp. American Pulpwood Association, 220 East 42nd St., New York 17, N. Y.

The Cold-Soak Preservative Treatment of Persimmon Posts. C. S. Walters and K. R. Peterson. Forestry Note 61. U. of Illinois Agricultural Experiment Station, Urbana, Ill.

Growth and Yield from a Second Row-Thinning in an 18-year-old Shortleaf Pine Plantation in Southern Illinois. W. R. Boggess and F. W. McMillan. Forestry Note 62. U. of Illinois Agricultural Experiment Station, Urbana, Ill.

Forest Products Research Guide, 1956. NLMA, 1319 18th St., N. W. Washington 6, D. C. $15 per copy. Reports research projects conducted by U.S., Russia, and more than 50 other countries.

The following publications are available without charge from the U. S. Forest Products Laboratory, Madison, Wis.

List of Publications January 1 to June 30, 1955.

Knots vs. Clear Lumber. Presents results of various methods of pruning trees and shows that efficient pruning develops more clear lumber.

How to Avoid Nail Popping in Dry-Wall Construction. R. F. Luxford. Report 2036.

Drying and Protection of Wood Items in the Original Round Form. E. C. Peck. Report 1187.

Bending Solid Wood to Form. E. C. Peck. Describes selection of bending stock, seasoning and plasticizing, machining, drying and fixing the bent part, and bending's effect on strength properties. Report 1764.

Animal Glues: Their Manufacture, Testing, and Preparation. Report 492.

List of Publications on Mechanical Properties and Structural Uses of Wood and Wood Products. Report 200.

Correlation Between Chlorine Number and Lignin Content of High-Yield Kraft Pulps. E. L. Keller and P. B. Borlew. Reprint from TAPPI.

Transfer of Longitudinal Load from One Facing of a Sandwich Panel to the Other by Means of Shear in the Core. C. B. Norris and K. H. Boller. Report 1846. Presents and verifies by test a mathematical analysis of certain shear stresses in sandwich panels of type used in aircraft construction.

Sapstain Control Treatments Before or After Dressing. Forest Pathology Special Release 27.

Special Methods of Seasoning Wood: Solvent Seasoning. Report R1665-2 (Rev.)

Partial List of Publications for Furniture Manufacturers, Woodworkers, and Teachers of Wood Shop Practice. Report 1775.

Service Tests on Posts as a Means of Evaluating Wood Preservatives and Methods of Treatment. J. O. Blew, Jr. Report 1726.

Wood Industries as a Source of Carbohydrates. A. J. Wiley, J. F. Harris. J. F. Saeman, and E. G. Locke. Data are presented on quantity, location, and character of wood and pulping residues in the U. S. Reprint from Industrial and Engineering Chemistry.

EMPLOYMENT SERVICE

Positions Offered

No. E 208—Chicago firm has opening for recent college graduate trained in chemistry and wood technology. Position entails formulation, development, and technical service work on furniture finishes.

No. E 209—Recent college graduate in forestry, wood utilization or wood technology wanted for training in management position in wood preserving industry. Salary $300 to start.

No. E 210—Adhesives company seeks recent graduates for sales training positions in Southeast. Training program and excellent starting salary.

No. E 211—Progressive Eastern hardwood distribution yard seeks recent graduate or experienced lumber salesman for sales territory in New Jersey and surrounding areas.

No. E 213—Large wood preservation company, plants throughout U. S., seeks young chemists or chemical engineers.

No. E 214—Lumber mills, headquarters Los Angeles, seek experienced supervisory and operating personnel. Consider applicants in age 40–50 bracket.

No. E 215—Large, diversified West coast forest products company, headquarters San Francisco, seeks experienced market analyst. Should have engineering, wood technology or forestry background. Excellent starting salary.

No. E 217—Midwest furniture plant seeks high grade time-study engineer. Should be forest products technologist.

No. E 218—Eastern furniture company seeks experienced lumber grader who can also buy lumber. Will be in charge of lumber shed and will determine kind and grade of lumber to go with each production order.

No. E 219—Chemist wanted with experience in the chemistry of wood and wood finishes. Salary open. Location, Pacific Northwest.

Employment Wanted

No. 187—Young executive, M. S. in utilization plus 10 years technical production and sales experience in hardwood plywood, structural laminates, and millwork. Age 33. Will locate anywhere.

No. 300—Chemical engineer, age 38, and 14 years experience in research and developing particle boards seeks west coast position. Requires $9,000 minimum.

No. 332—Young man, B.F. in forest products, B.S. in commerce, seeks position in Western lumber or plywood industry. Experienced in research and retail lumber. Age 26.

No. 333—Manager, commerce and legal degrees, age 41, 20 years experience in fine hardwoods and veneer industry as mill manager and assistant sales manager, seeks Midwest position in specific locale. Details upon request.

No. 334—Saw filer from African Gold Coast trained in United Kingdom desires additional temporary industrial trainee experience in U. S. Knowledge of grading, preservation, and classification of timber.

No. 335 — Young man, age 32, single, seeks position in furniture manufacturing. Graduate Vanderbilt University. For three years, head of own firm in wrought iron gift field.

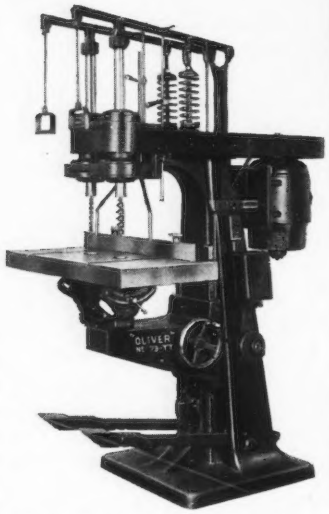
No. 336—March, 1956 forest utilization graduate, Colorado A & M College, seeks Western position in sawmilling production or wood utilization leading to sales or purchasing. Has experience operating a Wyssen Skyline Crane. Age 24, single.

No. 337—Young man, 27, married and a veteran, seeks position in marketing and economics research. Has advanced degree from U. of Michigan, experience as research assistant in forest products, plus three years pre-engineering background.

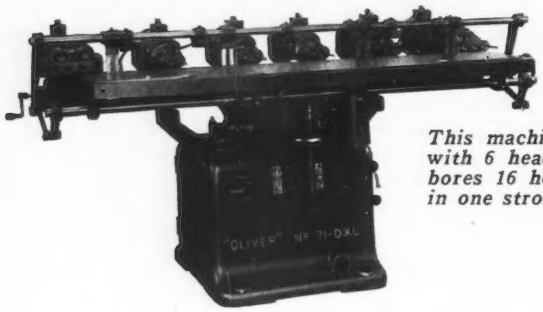
OLIVER Borers handle big jobs

These new machines help woodworkers solve production problems on hard-to-handle work

No. 73 Vertical Borer (single or double spindle) bores holes up to 3" diameter, 12" deep, to the center of 36"



The No. 73-TT has two independent spindles for boring two sizes of holes. Table is 18" x 30" with 17" vertical adjustment. Table tilts 40° to and from column, 15° to right and left. Graduated rockers indicate angle. Four-speed drive: 450, 610, 1020, 1900 RPM. No. 73-T Borer has a single spindle. Write for details.



This machine with 6 heads bores 16 holes in one stroke

No. 71-DXL carries up to 6 heads to bore holes from ⅞" to 83" between centers

This Oliver Borer has an extra long table and slide to bore holes up to ⅜" diameter, 3⅝" deep—up to 83" between centers of outside spindles. Automatic feed—8 to 22 strokes a minute. Automatic clamping—air or mechanical. Uses any Oliver direct motor driven, single or multiple spindle, fixed or adjustable center boring heads. Get all the facts.

Let our engineers help you solve your problems. Oliver makes an extensive line of vertical and horizontal Borers. Write for Bulletins.

OLIVER MACHINERY COMPANY

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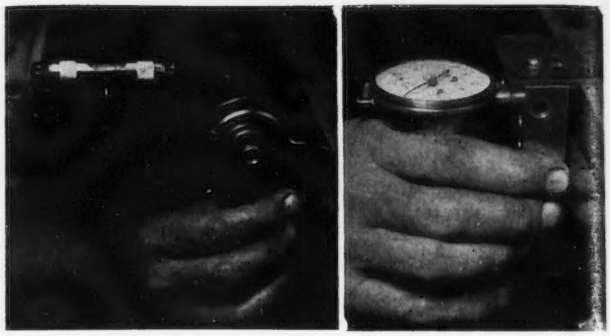
Two New Tools for *Precision* Veneer Cutting



PRECISION KNIFE ANGLE INDICATOR

PRECISION HORIZONTAL OPENING INDICATOR

Investigations show that smooth, accurate veneer can be cut consistently when these two precision instruments are used to set knife angles and horizontal opening between knife edge and nosebar. By keeping records of settings that give the best results, even a novice can acquire the skill necessary to cut good veneer consistently.

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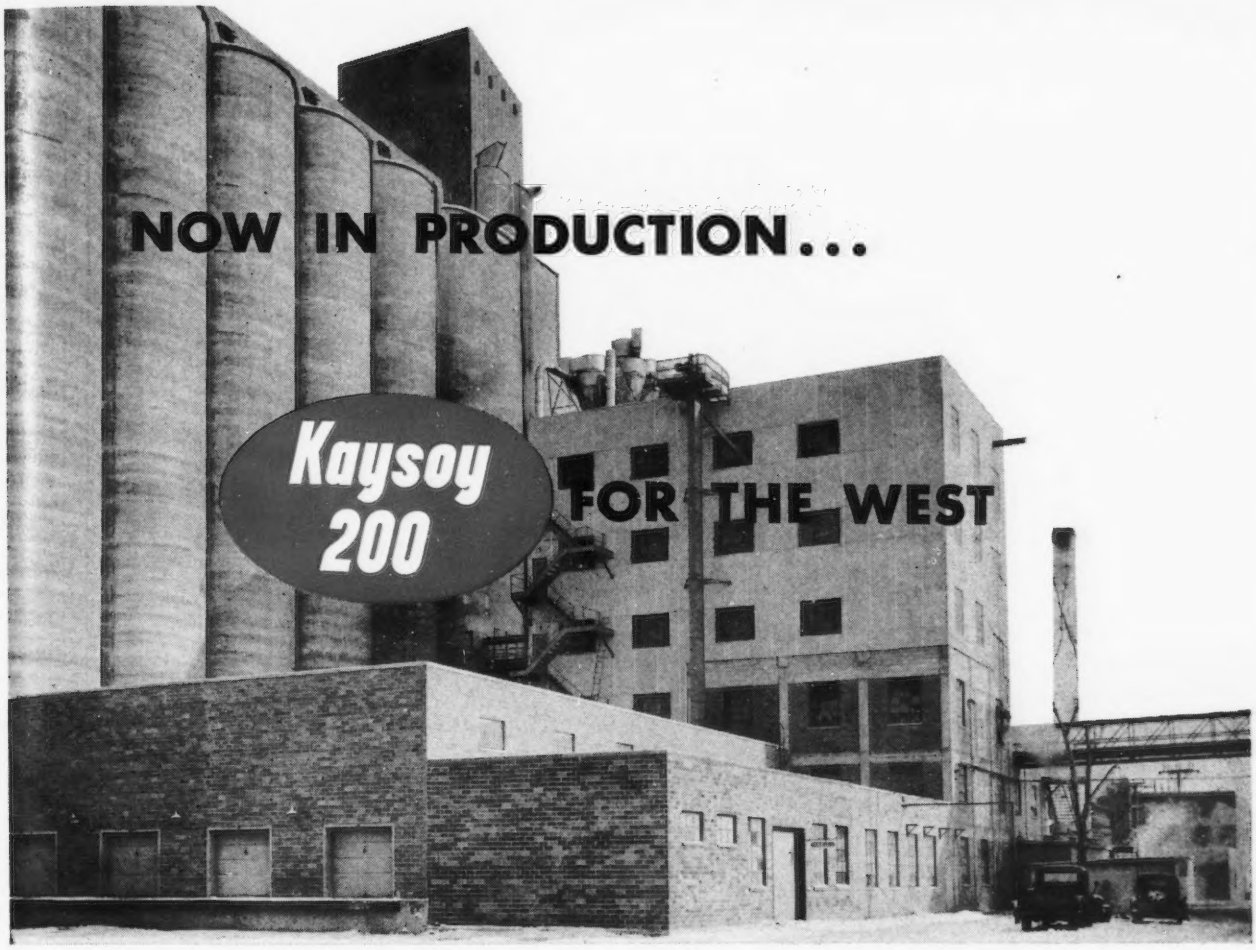

Production of Industrial Soy Proteins Starts at Mankato, Minnesota . . . Bulk loading facilities for airslide cars

With the completion of new processing facilities at Mankato, Minnesota, ADM is the first major processor of industrial soy protein to locate west of the Mississippi.

The Mankato plant offers unusually fast service and favorable shipping to western adhesive manufacturers. Excellent western rail connections make this possible. In addition, bulk loading facilities for airslide cars are an added attraction . . . costwise.

Kaysoy 200, a dehulled 50% soy protein, and *Kaysoy 144*, full-fibred 44% soy protein, are now in production. And like other ADM products the quality and uniformity are supreme . . . unsurpassed.

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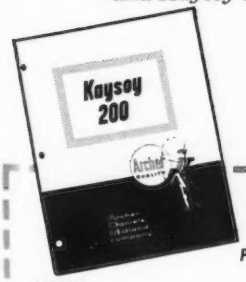

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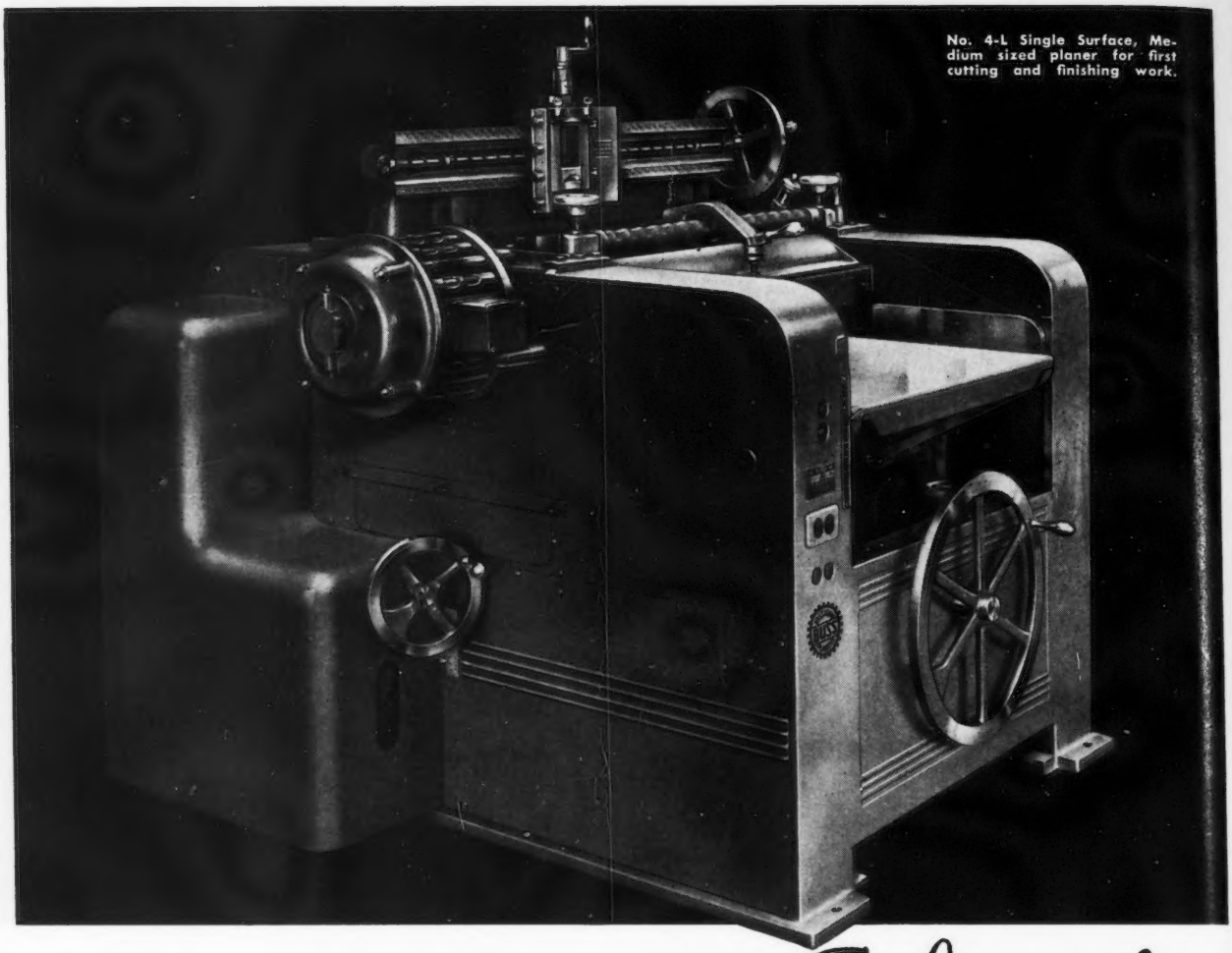

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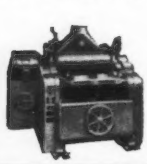
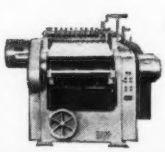


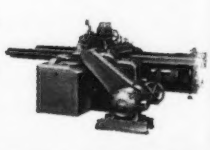
No. 66 Single Surface, 6 roll planer for first cutting and finishing work.

No. 88 Double Surface, 8 roll planer for first cutting and finishing work.

No. 55 Heavy duty Double Surfacer for planing rough lumber.



MICRO-SURFACER for planing hardboard and other very thin materials



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